

ABSTRACT

PARAMEDIC PROFESSIONAL AND LEADERSHIP DEVELOPMENT  
USING HIGH-FIDELITY HEALTHCARE SIMULATION AND  
AUDIOVISUAL FEEDBACK: ONE MICHIGAN  
COMMUNITY COLLEGE CASE STUDY

by

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Chair: Duane Covrig

## ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

School of Education

Title: PARAMEDIC PROFESSIONAL AND LEADERSHIP DEVELOPMENT  
USING HIGH-FIDELITY HEALTHCARE SIMULATION AND  
AUDIOVISUAL FEEDBACK: ONE MICHIGAN COMMUNITY COLLEGE  
CASE STUDY

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Date completed: December 2014

### Problem

Paramedic educators have a short time frame (840 didactic/laboratory plus 500 clinical/internship hours) and limited resources to prepare their students to have competent clinical skills, safe medical practice, and appropriate leadership and teamwork skills. New learning approaches including simulation, audiovisual feedback, and structured debriefing have been suggested as a way to meet this challenge within paramedic education. While some individual components have been studied, no study has examined these three technologies together in paramedic training programs. The overarching research question that guided this study was: What and how do paramedic

students learn in a high-fidelity healthcare simulation program that includes audio/video and instructor-facilitated feedback?

### Method

The investigation was a mixed methods study; however, the study tended towards qualitative methods primarily using intrinsic case study methodology based on the work of Yin and Stake. The investigation reviewed the outcomes achieved through the use of high-fidelity healthcare simulation coupled with audio-visual feedback, when implemented within a paramedic education program. A variety of data was collected including audio-visual recordings of briefs, simulations, and debriefs, multiple student documents and logs, and copious researcher notes and documents.

### Results

The simulation laboratory was a realistic, safe, controlled setting allowing students to make autonomous decisions without potential harm to human life as a consequence of errors. Simulation technology augmented traditional clinical experiences by providing more uniformity of experiences between students, providing less familiar clinical experiences, and acting as a time-efficient method for achieving deficit competencies. In evaluating student skill performance, simulation provided better quantified measures and observation accuracy.

Leadership skills were developed in simulation by taking advantage of safe learning aspects; an environment to learn from mistakes which used leadership skill autonomous practice. Participation as a leader and follower allowed the learner a better understanding of the leadership role when exposed to well-crafted scenarios. Simulation was a unique methodology facilitating safe learning from errors committed by students, a

result of knowledge gaps within individual learning. Simulation was unlike traditional learning methods such as lecture, laboratory, or clinical experiences.

The facilitator/debriefer assisted the paramedic in learning within the simulation environment by: creating a safe learning environment, helping learners identify what knowledge was needed, reinforcing identified needed learning, assisting participants to identify correct actions in response to individualized errors, and promoting learner reflection. A debriefing provided the environment whereby the bulk of learning took place in the simulation experience. The simulation environment contributed to student growth in three domains (cognitive, psychomotor and affective) of learning identifying knowledge or performance gaps for students in the specific practice of assessment, leadership, treatments, planning, evaluation, situational awareness, communications, and teamwork. Simulation provided an alternate method for achieving clinical experiences not available in the actual setting. During the debriefing, the audio-visual feedback and interactive probing procedures worked together to promote student learning. The audio-visual component provided a “big picture” viewpoint for the learner used by the debriefer during interactive probing to help students identify errors and alternate actions.

A learning model was constructed which represented how students learn. The use of simulation allowed the participant to determine unknown knowledge gaps from previous learning through processes of simulation experience, identification during debriefing, and reflection on alternate-decision pathways. Learning occurred in learning process conclusion: the application of alternate pathways in behavior. The learning process has been summarized in a simulation learning model presented in this study. The simulation learning model is applicable for cognitive, affective, and psychomotor elements.

Within the study, analysis developed emergent themes. Emergent themes included: *Context Is Vital, We Often Don't Know What We Don't Know, Learning From Mistakes, Learners Must Have a Safe Learning Environment, Learning Lessons From Other Industries, and Teaching Leadership Challenges for Paramedics.*

### Conclusions and Recommendations

Students often don't know what they don't know in individualized previous learned knowledge; thus, a learning mechanism is required, such as simulation with facilitated debriefing interactive audiovisual feedback. Simulation technology acts as a safe and non-threatening environment to allow learning from mistakes without a human cost. Valid fidelity healthcare simulations augment traditional clinical experiences by providing unfamiliar virtual realities in a uniform way to strengthen the participants' overall experience repertoire. This study recommends that the Emergency Medical Services (EMS) industry, educators, and policy makers establish standards requiring simulation learning within initial training programs to decrease the potential for loss of human lives as a result of human error.



Andrews University

School of Education

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AUDIOVISUAL FEEDBACK: ONE MICHIGAN  
COMMUNITY COLLEGE CASE STUDY

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Chester L. Dalski

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Chester L. Dalski

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## TABLE OF CONTENTS

LIST OF FIGURES .....	ix
LIST OF TABLES .....	x
LIST OF ABBREVIATIONS .....	xi
ACKNOWLEDGMENTS .....	xiii
Chapter	
1. INTRODUCTION AND BACKGROUND .....	1
Statement of the Problem .....	5
Purpose of Study .....	5
Research Question .....	6
Research Design .....	6
Conceptual Framework .....	7
Significance of Study .....	9
Basic Assumptions .....	10
Delimitations .....	10
Definition of Terms .....	11
Organization of This Study .....	12
2. LITERATURE REVIEW .....	13
Overview .....	13
Previous Similar Studies .....	13
EMS Paramedic Education Requirements .....	25
EMS System .....	25
Levels of Certification/Licensing .....	26
Protocols .....	27
Paramedic Curriculum .....	28
Competencies .....	28
Leadership in EMS .....	31
Medical Error Training and Leadership .....	33
Learning Teamwork .....	41
TeamSTEPPS/CRM .....	42
Simulation-Based Team Training .....	51
Situational/Perceptual Awareness .....	54
Emotional Intelligence .....	58
High-Fidelity Healthcare Simulation .....	61
Defining Fidelity .....	65
Learning Methodology .....	68
Debriefing Facilitation .....	75

Summary.....	81
3. RESEARCH METHODOLOGY.....	82
Introduction.....	82
Research Questions.....	83
Methods.....	84
Creating the Structure.....	87
Developing the Setting for the Study.....	88
How Modules Were Conducted.....	90
Data Collection.....	93
Analysis of the Data.....	94
Data Collected.....	95
Quality of Research Design.....	95
Construct Validity.....	97
Internal Validity.....	99
External Validity.....	100
Reliability.....	100
Ethics and IRB.....	101
4. FINDINGS: CONTEXT OF LEARNING.....	104
Introduction.....	104
Timeline.....	104
Initiating Simulation Into the EMS Program.....	105
Video and Feedback.....	107
Questions Emerge.....	108
Year 1: The Alpha Year.....	109
Integrating Simulations Into Programming.....	109
Transitioning to Better Program Designs.....	111
Year 2: The Beta Year.....	121
More Scenarios Added.....	122
Learning From Related Industries Applied.....	123
Debriefing Improved.....	124
Year 3: A New Sim Lab.....	125
Simulations Added.....	126
Specific Clinical Site Shortages.....	127
Prioritization of Scenarios.....	128
Data Collection Improved.....	128
Year 4: Deeper Questions Emerge.....	129
Additional Data Collected.....	129
Context of Learning Summary.....	130
5. FINDINGS: QUANTITATIVE DATA.....	132
Simulation Conducted.....	132
Student Participant Demographics.....	140
Competencies Achieved Through Simulation.....	145

6. FINDINGS: QUALITATIVE DATA.....	150
A Student View of the Simulation Environment.....	151
Realism.....	151
Controlled Environment.....	153
A Safe Place to Make Mistakes.....	153
Students' Perception of Simulation-Based Competencies Achieved.....	155
Quality of Simulation-Based Competencies.....	155
Could Simulated Competencies Be More Effective Than Live?.....	157
Simulation Comparison to Traditional Clinicals.....	157
Problem of Uniform Experiences.....	158
Simulation-Based Clinical Experiences.....	159
Time Spent Versus Experiences Gained.....	160
Simulated Versus Live Clinical Experiences.....	160
Students' View of Audiovisual Use.....	161
A Different Viewpoint.....	162
The Big Picture.....	163
We Don't Know What We Don't Know (Part 1).....	163
Video Builds Confidence.....	164
Instructor-Facilitated Feedback.....	164
Facilitated Debriefing Produces Learning.....	165
We Don't Know What We Don't Know (Part 2).....	167
Tunnel Vision.....	170
Other Important Skills and Knowledge.....	171
Learned Leadership.....	171
The Leadership Experience.....	171
Responsibility.....	173
Learning Teamwork.....	173
Command and Control.....	175
Situational Awareness (Perceptual Awareness).....	176
Sustained Inattention Blindness.....	177
Planning.....	179
Dealing With Stress.....	180
Communication.....	181
A Student View From the Control Room.....	184
Seeing the Big Picture.....	184
Comparison to Being a Participant.....	185
The Script.....	185
Busy Sim Operators.....	186
Observations of Classmates.....	186
Quality and Direction of Debriefings.....	188
Observed Errors.....	189
Reason's Classification.....	190
Active Errors.....	191
Anchoring.....	191
Ascertainment Bias.....	192
Commission Bias.....	193

Confirmation Bias .....	194
Diagnosis Momentum .....	194
Framing Effect.....	195
Omission Bias .....	195
Overconfidence Bias .....	196
Posterior Probability Error .....	197
Premature Closure .....	198
Unpacking Principle.....	198
Visceral Bias .....	199
Specific Errors.....	200
Assessment Errors .....	201
Safety Errors.....	206
Medication Errors.....	209
Other Medical Errors.....	213
Communications Errors.....	220
Situational Awareness .....	225
Leadership Errors .....	227
Summary of Specific Errors.....	232
Learning About Simulation Technology .....	233
What Manikins Do Well.....	233
What Manikins Don't Do Well .....	235
Technology and Failure.....	236
Use of Standardized Patients.....	237
Environmental Simulators.....	239
Creative Props .....	240
Down the Rabbit Hole.....	242
Teamwork Among the Sim Operators.....	243
What Students Say They Learned.....	244
Experiencing the Uncommon Clinical Experiences.....	245
Self-Knowledge and Evaluation.....	246
Objective Evaluation of Skills.....	247
Assessment Inadequacies .....	248
Specific Procedures and Treatments .....	249
What Students Say Caused the Learning.....	251
Themes Repeated .....	251
Simulation Versus Lab, Lecture, and Clinical Learning.....	253
A Fourth Form of Learning? .....	255
Easy or Hard? .....	255
Domains of Learning .....	258
Psychomotor Domain .....	258
Affective Domain .....	259
Cognitive Learning.....	261
A Combination of Three Learning Styles .....	262
What Students Say About Simulation Importance .....	262
Least Beneficial Parts of the Simulation Experience .....	263
Value of Simulations.....	265
A Model for EMS Education.....	267

7. CONCLUSIONS AND RECOMMENDATIONS .....	268
Emergent Themes .....	268
Introduction .....	268
Context Is Vital .....	269
We Often Don't Know What We Don't Know .....	270
Learning From Mistakes .....	272
Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs .....	274
Learners Must Have a Safe Learning Environment .....	277
Learning Lessons From Other Industries .....	281
Teaching Leadership Challenges for Paramedics .....	283
Sub-Question Answers .....	285
Sub-question 1: Student Description High-Fidelity Simulation.....	285
Sub-question 2: Augmentation of Clinical Experiences .....	288
Sub-question 3: Facilitator/Debriefers in High-Fidelity Simulation .....	294
Sub-question 4: Simulation Environment in High-Fidelity Simulation .....	297
Sub-question 5: Audiovisual Feedback .....	299
Sub-question 6: Leadership Skills .....	301
Sub-question 7: Simulation Learning.....	303
Simulation Learning Model.....	306
Knowledge Gap.....	307
Simulation Experience .....	308
Debriefing Experience.....	309
Reflection .....	310
Re-entry Into Knowledge Gap .....	312
Summary .....	312
Overarching Research Question Answer.....	312
Contributions to EMS Education Research .....	315
Conclusions.....	316
Conclusion Learning Points.....	317
Limitations .....	318
Recommendations.....	320
Future Student Practitioners .....	320
Educators .....	320
Administrators .....	321
Policy Makers.....	321
Researchers.....	322
Manufacturers.....	323
The EMS Industry .....	323
Appendices	
A. SAMPLE SCENARIO FROM INTRODUCTION MODULE .....	326
B. IRB CONSENT AND APPROVALS .....	336
REFERENCE LIST .....	340

VITA.....354



## LIST OF FIGURES

1. Algorithm for Distinguishing Behavior Varieties That Result in Human Errors.....	39
2. Negative–Positive Loop Learning. ....	45
3. Reason “Swiss Cheese” Model of Human Error and Accident Causation.....	46
4. The Emotional Intelligence Competency Framework. ....	60
5. Common Steps in High-Fidelity Simulation.....	69
6. Kolb Experiential Learning Theory. ....	70
7. Case Study Research a Linear Iterative Process.....	86
8. Diagram of Years, Modules, and Simulations. ....	133
9. Graph of Briefing, Simulation, Debriefing, and Total Simulation Time.....	139
10. Slide on Confidentiality. ....	279
11. Safe Learning Environment Slide.....	279
12. Dalski Learning Model.....	307

## LIST OF TABLES

1. Cognitive Errors Observed in Medical Practice .....	36
2. Summary of Collected Data.....	96
3. Data Usage Within the Study.....	98
4. Total Simulation Modules by Year.....	134
5. Scenarios Conducted by Year.....	135
6. Total Time in Simulation.....	138
7. Total Individual Student Hours by Year.....	140
8. Student Demographics .....	142
9. Previous Simulation Experience and Opinions.....	144
10. Summary of Total Competencies by Year.....	146
11. Ranking of Competencies Achieved Through Simulation .....	147
12. Competency Experiences by Student Hour .....	148
13. Calculation Time for Paramedic Completion of Competencies .....	149

## LIST OF ABBREVIATIONS

ACLS	Advanced Cardiac Life Support
ACRM	Anesthesia Crew Resource Management
AEMT	Advanced Emergency Medical Technician
AHRQ	Agency for Healthcare Research and Quality
BLS	Basic Life Support
CRM	Crew Resource Management
EMS	Emergency Medical Services
EMR	Emergency Medical Responder
EMT	Emergency Medical Technician
EMT-B	Emergency Medical Technician Basic
EMT-P	Emergency Medical Technician Paramedic
EMS-I/C	Emergency Medical Services Instructor-Coordinator
HFHS	High-Fidelity Healthcare Simulation
HFMS	High-Fidelity Medical Simulation
IOM	Institute of Medicine
ITLS	International Trauma Life Support
LOFT	Line Oriented Flight Training
LFMS	Low Fidelity Medical Simulation
MFR	Medical First Responder
NAEMT	National Association of Emergency Medical Technicians
NHTSA	National Highway Traffic Safety Administration
PALS	Pediatric Advanced Life Support

RN Registered Nurse

TeamSTEPPS Team Strategies and Tools to Enhance Performance and Patient Safety

TJC The Joint Commission

USDOT United States Department of Transportation

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The second acknowledgment is that of my family, especially my wife Brenda and my children Chester S., Diana Jo, Jordan, Jacob, and Jessica. Pursuing a PhD while working full-time is very difficult and time-consuming. Throughout it, they have been understanding and given me the space I need to get it done. I now pass the torch to all of them to continue their educations as I have. Education is something that can never be taken away from you. It is a method to continue to improve one generation over another.

My third acknowledgment is to those who have helped push me along towards completion of this degree. These include: Dr. David Maysick and Dr. Paul Ohm who encouraged me and wrote letters of recommendation towards my acceptance at Andrews University; James Stevens who has been a personal friend and mentor throughout my career at Kellogg Community College; and my leadership and learning group members of the Michiana Pacesetters who approved my competencies and provided support throughout this process. All of you made a difference in my life.

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For you, the reader, I hope you are able learn something you can apply to your work by reading this study. While long and detailed, I have written it as a roadmap to what we did when we learned this precious ability. When I started this work, high-fidelity healthcare simulation was in its infancy as an industry. Today, I feel as if it has achieved teen-age status requiring researchers like myself to help nurture and guide it in its development. I look forward to seeing it as an adult.

## CHAPTER 1

### INTRODUCTION AND BACKGROUND

In 2011, approximately 11,440 paramedics in the United States were educated, trained, and took the National Registry Examination (National Registry of Emergency Medical Technicians, 2011). Training consisted of 500 hours in clinical observation/internship and 840 hours in didactic/laboratory teaching (NHTSA, 1998). As part of this competency-based education, clinical internships and both practical skills and cognitive knowledge testing methods were employed. Difficulty has been reported for competency completion in the specific areas of un-intubated patient ventilation, obstetrics/gynecology, pediatrics, mental health, and adult respiratory distress (Salzman, Page, Kaye, & Stetham, 2007). While a minimum number of assessments or skills are required to obtain compulsory competencies, there has been no recommendation on the quality of clinical experiences (State of Michigan, 2007; U.S. Department of Transportation, 2009).

The 1999 Institute of Medicine (IOM) reported in *To Err Is Human: Building a Safer Health System* that between 44,000 and 98,000 needless deaths occurred in medicine each year due to human medical errors. Medical deaths, due to preventable medical errors, have been found as the eighth leading cause of death in the United States. Besides the human cost, the economic losses amounted to between \$17-29 billion annually. There were many recommendations in the IOM report, but an important one of



interest to this study was the need to pattern medical practices after high-risk industries such as the chemical industry, airline transportation, and nuclear power (Kohn, Corrigan, & Donaldson, 2000).

In high-risk industries, the use of high-fidelity simulation has been crucial to refining team behaviors in preparation for actual operations (Doucette, 2006; Flin, O'Connor, & Mearns, 2002; Helmreich, Merritt, & Wilhelm, 1999). Crew Resource Management (CRM), used in aviation and other industries, has been a team operations methodology practiced by crews using high-fidelity simulation. Within simulated environments, crews were trained using demanding problems encountered at various frequencies within flight operations. Their actions were audio-video recorded and reviewed in a very structured reexamination program (McDonnell, Jobe, & Dismukes, 1997). Given the similar nature of challenges in medicine, previous researchers have called for the systematic application of high-fidelity simulations to medical training (Doucette, 2006; Kohn et al., 2000; Riley, 2008).

Multiple investigations across the spectrum of medicine have documented poor teamwork and communication skills (Cannon-Bowers & Salas, 1998; Hunziker, Tschan, Semmer, Howell, & Marsch, 2010; Sexton, Thomas, & Helmreich, 2000). The pre-hospital medical setting is Emergency Medical Services (EMS). Studies have shown EMS, one segment of medicine, while comparable to the larger medical community, has not been immune and potentially may even be more at risk for poor teamwork and communication skills problems. In a pediatric study of 5,547 patients, 34.7% had medication dosing errors by paramedics in the pre-hospital segment of treatment compared to 17.8% medication dosing errors in the hospital setting. The reported errors

included both underdosing and overdosing errors (Hoyle, Davis, Putman, Trytko, & Fales, 2012). Unfortunately, findings gave only a glimpse of errors which have extended beyond just pediatric patients.

From the IOM report, it is known that sentinel events have been a leading cause in the rising national costs of providing healthcare. A sentinel event, as defined by the Joint Commission (TJC), is an “unexpected occurrence or variation involving death or serious physical or psychological injury or the risk thereof” (Kohn et al., 2000, p. 93). The actions or inactions of the paramedic during sentinel events can alter the patient outcomes. Could including education and simulated practice in the recognition of sentinel events improve paramedic education? Education, training, practice in leadership skills, communications, team work, and organizational cultures conducive to error prevention have been shown to significantly decrease the lethal incidence of sentinel events (Ander, Heilpern, Goertz, Click, & Kahn, 2009; Crofts et al., 2006, 2007; Draycott et al., 2008; Gaba, 2004). However, specific details on improved paramedic education regarding sentinel events were not released until the 2009 National EMS Education Standards. The 387-page report contained only a half-page dedicated to patient safety and error prevention (U.S. Department of Transportation, 2009, p. 9). Paramedic education textbook publishers have yet to address the needed aforementioned sentinel events educational training specifics.

The costs, time, and money to educate a paramedic have been shown as significant. The requirements to educate a paramedic have significantly increased over the past two decades. Rapidly changing advancements in technology, medical knowledge and lifesaving techniques have resulted in improved trained graduates, but at an

additional time cost and a need for increased learner critical-thinking skills. Decreasing the training time while maintaining or improving the quality of education obtained could result in significant time savings decreasing education costs.

Within the paramedic education program clinical component, a minimum of 500 hours must be spent in the hospital and pre-hospital environments observing and treating patients. While there are recommendations for the clinical component to be 250-300 hours in the clinical environment (hospital based) and 250-300 hours in the field internship (pre-hospital based), there has been no requirement as to specific patient conditions experience requirements (U.S. Department of Transportation, 2009). For example, within the obstetric clinical rotation, a paramedic student could easily have few patients with normal cephalic deliveries, and no experiences with abnormal deliveries. Yet, in the pre-hospital setting, once graduated, licensed, and employed, the paramedic could be responsible for managing an abnormal obstetric condition for the first time, potentially leading to a sentinel event. The experience of treating patients during potential sentinel events has not been required in paramedic pre-hospital education. Though information on specific medical problems that lead to sentinel events is presented, in reviewing the national and Michigan paramedic curriculum and leading paramedic textbooks, no evidence was found which specifically teaches identifying and managing sentinel events as a team (Beebe & Myers, 2009; Bledsoe, Porter, & Cherry, 2008; NHTSA, 1998; State of Michigan, 2007; U.S. Department of Transportation, 2009).

Finally, limited paramedic training has existed in specific leadership teamwork skills. Leadership has been described as a vital non-technical aspect of emergency medicine. By definition, “non-technical skills are the cognitive and social skills that

complement [a] workers' technical skills" (Flin, O'Connor, & Crichton, 2008, p. 1). The National Registry of Emergency Medical Technicians *2009 Practice Analysis* reported that to "provide scene leadership" was one of the nine EMS worker operational duties (2010, p. 4). Within the national and Michigan paramedic educational setting curriculums, in addition to the clinical education experiences, the paramedic must demonstrate team leadership in order to be considered competent. Yet, practice of leadership skills prior to the internship is limited. Therefore, the non-technical skills of leadership and teamwork development in paramedic education have been identified as a concern (State of Michigan, 2007; U.S. Department of Transportation, 2009).

### **Statement of the Problem**

Paramedic educators have a short time frame (840 didactic/laboratory plus 500 clinical/internship hours) and limited resources to prepare students in competent clinical skills, safe medical practice, and appropriate leadership and teamwork skills (NHTSA, 1998). Competencies and the aforementioned curriculum are important in paramedic students' preparation to handle sentinel events in pre-hospital medical care. New learning approaches including simulation, audiovisual feedback, and structured debriefing have been suggested as a way to meet this challenge within paramedic education. While some individual components have been studied, no study has examined simulation, audiovisual, and debriefing technologies as a curriculum in paramedic training programs.

### **Purpose of Study**

The purpose of this research was to describe the student learning taking place using high-fidelity healthcare simulation within a paramedic education program at a

community college. The paramedic education program used audio-visual recordings and instructor-mediated debriefing feedback.

### **Research Question**

The overarching research question guiding my study was: What and how do paramedic students learn in a high-fidelity healthcare simulation program that includes audio/video and instructor facilitated feedback? To better answer the research question, seven sub-questions were developed.

1. How do students describe high-fidelity healthcare simulation instruction?
2. How do high-fidelity healthcare simulations augment clinical experiences for paramedic students?
3. How does the facilitator/debriefer assist the paramedic in learning within a high-fidelity simulation environment?
4. How does the simulation environment contribute to student learning?
5. How does the facilitated audio-visual feedback in debriefing influence the student learning?
6. How does the simulation experience develop leadership skills?
7. What kind of learning is healthcare simulation uniquely designed to provide?

To answer the questions, I determined that primarily qualitative research methodology would be the most effective design.

### **Research Design**

This study used a mixed methods research design; however, the investigation tended towards qualitative methods primarily using intrinsic case study methodology

based on the work of Yin (2009) and Stake (1995). Intrinsic case study focuses on specific cases imbedding the researcher within the process in attempting to understand questions researched. In this case, the specific embedment occurred within a setting where the use of high-fidelity healthcare simulation was used to facilitate learning.

Intrinsic case study research requires close attention to context (Stake, 1995). This study reviews the outcomes achieved through the use of high-fidelity healthcare simulation coupled with audiovisual feedback, when implemented in a paramedic educational training program. The specific contexts that occurred are discussed in detail.

Yin's (2009) case study research defined the elements of Plan, Design, Prepare, Collect, Analyze, and Share. Yin's (2009) case study research processes were used in context and research question development. While mainly qualitative in nature, quantitative research methods were used in tracking simulation data including the number of simulations conducted by year, and hours of simulation by year and module, and comparisons between competencies achieved by simulation versus traditional clinical methods.

### **Conceptual Framework**

The process of high-fidelity healthcare simulation is an experiential one for the learner. Kolb's Experiential Learning Model (1983) described how humans learn from experiences. Kolb argued that individuals learn on a continuous circle of learning, which includes concrete experiences. Following learning experiences, students reflected on the outcomes of actions or inactions and created mental relationships between actions and effects. In the continuous circle of learning, students formed a new mental model for what actions were needed when given a similar experience. Students then tested the new

mental model for use in future encounters; thus, new concepts learned became permanent actions (Kolb, 1983; Kolb, Boyatzis, & Mainemelis, 2001).

A potential problem with experiential learning is that without proper definition to the experience, improper learning can take place (Savoldelli et al., 2006). Savoldelli et al. found the use of videotaped facilitated feedback was superior to oral feedback or no feedback in learning; the research sample was anesthesia students. Novice students in a profession require feedback to enable effective reflection (Westberg & Jason, 2001). Like Kolb, Schön (1983, 1987) believed in the use of reflective practice for learning; however, Schön contended that reflective practice was a necessary learning component when seeking a competent professional outcome. He described the term *knowing-in-action* as knowledge gained from individual experiences. Knowledge-in-action has helped professionals to identify similar situations and apply previous situational learning in authentic decision-making. When previous learning was applied to a new situation, Schön termed it *practicing-in-action*. Schön stated that professional knowledge was only effective if applied in new situations.

Kolb, Schön, Westberg, and Hilliard have all formed the backdrop conceptual framework which is utilized in my research to study the learning of paramedic students. The process of valid fidelity healthcare simulation utilizes aforementioned frameworks as part of the learning processes. The practice of simulation sets the stage for Kolb's experience. Experiential reflection in student debriefing utilizes the concepts by Schön, Westberg, and Jason in presenting feedback as constructive and generating a reflective cycle of learning on the part of the student.

## **Significance of Study**

From the research collected in the IOM report *To Err Is Human*, medical errors and omissions resulted between 44,000 and 98,000 preventable deaths each year. This statistic does not include the survivors of medical errors resulting in permanent injuries and disabilities (Kohn et al., 2000). As a branch of medical care, the pre-hospital EMS treatment of patients, as demonstrated by research studies, has contributed to the number of medical errors (Hoyle et al., 2012; Jones, Murphy, Dickson, Somerville, & Brizendine, 2004; Katz & Falk, 2001; Rittenberger, Beck, & Paris, 2005; Vilke et al., 2006). From the IOM report, the use of high-fidelity simulation to train medical practitioners in safe practice, similar to other high-risk industries, can result in reduction of potential medical errors.

Evidence has shown high-fidelity healthcare simulation can be used to reduce paramedic errors. In a study using the Meti Human Patient Simulator, paramedics provided with simulation training reduced medical errors over the traditional case-study learning method (Wyatt, Fallows, & Archer, 2004). High-fidelity healthcare simulation has been used to decrease errors and omissions while increasing learning in other healthcare fields (Deering, Rosen, Salas, & King, 2009; Deering et al., 2006; Gardner, Walzer, Simon, & Raemer, 2008; Rodgers, Securro, & Pauley, 2009). If high-fidelity healthcare simulation implemented in the training of paramedics can demonstrate usage as a superior learning methodology, meaning transfer of knowledge and skills to novice employment settings, then the potential results could be decreased medical errors and omissions committed and improved pre-hospital survival rates.



## **Basic Assumptions**

This study assumed the current education model for providing clinical experiences to paramedics within a training program needs improvements. Likewise, the study assumed current learning methodology for providing paramedical clinical experiences has been limited in terms of obtained quality and quantity experiences. Finally, the study assumed the possibility of better methods for educating paramedics than the standard clinical internship and clinical experiences which have currently served as the model for the Paramedic National Standard Curriculum (NHTSA, 1998).

The study assumed theories applied were valid for use in paramedics' medical training. Theories included Kolb's Learning theory, Emotional Intelligence theory, Schön's Reflection in Action theory, and the Simons and Chabris Perceptual Awareness theories. Finally, the study utilized many of the concepts presented within the U.S. Department of Health and Human Services program *TeamSTEPPS* adopted in many healthcare agencies, a methodology considered for improving quality and patient safety.

## **Delimitations**

Within this study, I examined one community college, one primary instructor/researcher, and two secondary instructors. A decision was made limiting the investigation to one community college due to the depth and breadth of the topic studied and the anticipated time needed and resources available. The community college selected was willing to modify the facilities in order to meet the study needs for paramedic simulation.

The study was limited to one manufacturer of high-fidelity training manikins. The Gaumard series of manikins was chosen due to its wireless capabilities, availability of

different ages and medical conditions, and ease in programming. No other manikin manufacturer had this variety of simulators available. The result of the investigation does not assume to know whether or not other manufacturers' products would produce similar results.

### **Definition of Terms**

Key terms and words used throughout this study are defined in alphabetical order below.

*Audiovisual feedback:* Electronically recorded audio and video recordings that show the viewer the exact actions they took during an event such as a simulation.

*Commission Error:* An error caused by the direct action of a practitioner (Reason, 1990).

*Fidelity:* "The degree to which the real world is reproduced or simulated" (Riley, 2008, p. 44).

*High-Fidelity Healthcare Simulation:* "High" refers to the level at which the fidelity of the simulation environment transfers to the actual item, in this case the real world of medicine (Vincenzi, Wise, Mouloua, & Hancock, 2009).

*Medical Error:* "Medical errors can be defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (Kohn et al., 2000, p. 28).

*Omission Error:* An error caused by the inaction of a practitioner where it is warranted (Reason, 1990).

*Paramedic:* An individual who provides medical care often outside the hospital environment for patients suddenly taken ill, sick or injured. Education and training consists of 1½ to 4 years of post-secondary education with focus on emergency medicine.

*Pre-hospital:* Segment of medical intervention which occurs outside of or prior to the arrival at the hospital. It may take place in other skilled centers such as nursing homes, ambulatory care centers, and rehabilitation facilities or unskilled areas such as work, home, and community areas.

*Sentinel event:* Defined by the Joint Commission (TJC) as “unexpected occurrence or variation involving death or serious physical or psychological injury or the risk thereof” (Kohn et al., 2000, p. 93). Sentinel events are known to have grave consequences in the costs of human lives. Most sentinel events are preventable.

*Simism:* A term coined by my research in this study to describe something that could not be fully simulated by current technology. Suggests work-around to within the simulation for a specific situation such as putting a Post-it note on ankles stated “pitting edema.”

### **Organization of This Study**

The study has been organized into different chapters. Chapter 1 provides an overview and introduction to the study. Chapter 2 presents data from related previous research. Chapter 3 describes the research methodology used to complete the investigation. Chapter 4 represents the context to learning which initially occurred. Chapter 5 states the findings or data collected in relationship to the research question. Finally, Chapter 6 shares the conclusions and implications derived. A reference list and appendices are included.

## CHAPTER 2

### LITERATURE REVIEW

#### **Overview**

In my review of previous research, I first focus on previous studies which have similarities to my own in that they study medical simulation or feedback and videos in a health education environment. In addition, I review three elements of my research that include the current EMS education requirements, teamwork learning, and high-fidelity healthcare simulation with an emphasis on debriefing as a learning methodology. The current EMS education requirements can help one to understand the conditions and regulations under which this study was performed since it involved an EMS paramedic cohort of students. The teamwork section presents a lot of the information that was delivered as part of the simulations. Finally, the simulation section presents how the methods were delivered including information on feedback that is needed to understand the learning process.

#### **Previous Similar Studies**

The Clendinneng (2011) case study shared a similar purpose to my study in that she wanted to look at the learning of nurses in a simulation environment with feedback. She examined nine learners, colleagues, and herself performing simulations within a post-graduate perioperative nursing program. She studied participant perceptions, learning, and the facilitators' experiences. The data included in the Clendinneng study

included observations, video capture of simulations and debriefings after simulations, semi-structured interviews, and learner journaling. She collected data around 15 simulations within a 30-hour laboratory course. Four faculty were observed conducting the simulations. Videos of the simulations were recorded and then reviewed in full by the students. A debriefing lasting 15-30 minutes then occurred, which included both faculty and students.

Clendinneng (2011) found several aspects of the course beneficial to the learners and facilitators. She found that students changed their future behavior after viewing their performance on the video. Almost like seeing in the mirror what you are doing wrong, the students were able to self-correct on many tasks. Nevertheless, despite students self-identifying mistakes, often the facilitator was required to isolate and highlight certain actions that were not useful, thus identifying and educating the learners on what they missed. Students felt they could transfer the simulation experiences to a deeper confidence and understanding in actual clinical practice although Clendinneng acknowledged this was an unproven aspect of her study.

The Clendinneng (2011) study also raised several concerns about learning. Nurses with previous skills and experience did not find the simulations beneficial to their specific learning. This perceived lack of learning had several possible explanations. Initially, Clendinneng attempted to conduct simulations at a ratio of nine learners to one facilitator, which may have been too high and then to a ratio of 3:1, which may have prevented some good team dynamics. It also appears that some simulations did not have clear planning and pre-session skill development. It appeared that skills needed to be taught by the facilitator prior to their use of simulations. Also, props and conditions were

present that were not effective at supporting a suspension of disbelief within the scenario. Role clarification may also have been needed since the study of communications between the facilitators, student learners, and within the team were not a focus in this study. This lack of role clarification may have contributed to results. There were also some confidentiality concerns expressed by students who feared their sharing of experiences might result in retribution by others present in the simulation. Finally, during debriefings, the debriefer often used all of the video instead of selected segments for discussion. This may have resulted in debriefing sessions without focused learning.

The debriefing part of the study also held useful ideas for my study here. Based on her experience, Clendinneg (2011) proposed a more holistic definition of post-simulation debriefing. She stated:

Debriefing is the review of a performance over time that guides purposeful learning from the experience. It is an intentional communication and learning event based on mutual respect and a quest for knowledge on the part of all participants—both learners and facilitators. Whether verbal, written, or visual, effective debriefing helps a person make cognitive links from events that allow for improved future performance thus transforming professional practice. (Clendinneng, 2011, p. 147)

Clendinneng's (2011) qualitative study informs my study in that both focus on studying learning using high-fidelity healthcare simulation, debriefing and audio-video feedback as a methodology to promote that learning. Several differences also exist between her focus and mine. EMS operates on a medical model, which includes autonomy and self-guided actions, based on protocols. This creates a higher focus of my study on leadership, initiating behaviors, and decisive action within a team setting. My study is therefore more focused on teamwork, leadership, clinical and communication skill development, and safe medical practice as paramedic groups learn. Because my focus is teamwork based, I view simulation groups as a whole and focused on similar

problems and experiences that all shared during the course of simulations. It is that basis that I used to answer my overarching research question.

Another study by Conejo (2010) utilized a mixed methods approach to examine 12 nurse educators' and 140 nursing students' perceptions of high-fidelity healthcare simulation from five community college campuses. The total number of simulations each student and site utilized was unreported. Like my study, Conejo examined the use of high-fidelity simulation to augment the learning and clinical performance of her nursing students in preparation for entering the clinical setting. She also researched what the best practices were for the use of simulation within the program. As part of her focus, she examined the use of feedback in the debriefing to foster learning.

Unlike my study, her framework utilized the nursing education simulation framework (NESF) which bases itself on the components of teacher, student, educational practices, design characteristics and outcomes. Also, her study involved surveys of students and instructors at five institutions utilizing high-fidelity healthcare simulation in their curriculums. Conejo's (2010) study had no review of video-recordings or viewing of actual students in simulation, but instead was a post-simulation overall evaluation of their experiences. All information was obtained through the use of surveys with students and educators.

Within Conejo's 2010 study, there were a number of themes that she found which have direct application to my work. She found that educators had to prepare the students for learning including expectations on how they should conduct themselves during the simulation. It was important that the simulation fit into the students' curriculum, reinforcing important concepts for their future success. She found that assuring the

highest degree of realism and fidelity was key to a successful simulation. Educators had to have sufficient self-development to properly conduct the simulations. One of her educators commented in the study,

Simulations are an immersive, and have an emotional, stress response for the student. This is not just learning about congestive heart failure; this is about knowing how to think, prioritize, and respond safely when time is critical for the patient outcome. (Conejo, 2010, pp. 94-95)

In the Conejo (2010) study, students liked best the ability to learn from their mistakes, learning in a “safe” environment where mistakes did not have the severe consequences as in real life, and the preparation this gave them for real-life practice. Students in the study commented, “after a while it feels real” and “you forget that it’s not a real person” (Conejo, 2010, p. 109). Students also experienced the opposite feelings. Students at some sites voiced that they felt it to be artificial or unreal when compared to real clinical experiences. At some sites, they had concerns about a lack of fidelity in the plastic manikins versus live humans. In addition, there was a constant concern by some regarding being viewed by others on video. Both of these resulted in a failure to suspend disbelief in the simulation. In terms of patient size, students preferred smaller group sizes (2-4 students) within a simulation. Many of the findings of this study have application to my research.

Similar to the Conejo study, Kathleen Kuznar (2009) used mixed methods to study the effects of high-fidelity simulation on first-semester associate degree nursing students. She studied two colleges with 84 students split into two groups of 54 utilizing simulation versus 30 non-simulation traditional learning methodologies. After interviewing the students, Kuznar found the experimental group themes included recognizing the importance of comprehensive skill practice, the importance of risk-free



practice, the need for group participation, and the perception that there was a high value in the use of debriefing and instructor feedback as part of their process. Overall knowledge also improved within the experimental group as evidenced by a written examination administered to both groups (Kuznar, 2009).

In a related case study, Rita Van Horn (2000) used the methodology of student journaling to understand the students' learning process within the clinical setting. She found that when students worked in pairs in the clinical setting, greater learning occurred. Using a reflective process of learning improved learning. Within her dissertation, she stated,

The clinical experience is often unpredictable and difficult to control. The nurse-educator not only needs to ensure that the nursing student acquires knowledge and problem solving ability, but needs to protect the patient from harm by ensuring that the student practices safe care. (p. 6)

Her study points out the advantages of connecting reflection to understanding the connection between theory and practice (Van Horn, 2000). Within the debriefing segment of the high-fidelity healthcare simulation, reflective practice with instructor-mediated feedback is utilized to aid the learners in applying the theories they have learned to practice what they are being prepared for. This is directly linked to what I am studying.

Corrigan, Hardham, Cant, and Mort (2011) utilized mixed methods to examine the use of audio-video technology to record 60 physical therapy students performing a simulated practical exam on each other in groups of three. There were a number of pre-simulation themes that emerged including concerns over possible technical problems that would occur, their own lack of preparation, the instructor not being present in the same room as the students giving immediate feedback, and the stress of being observed. After performing the simulations, the students indicated that it was a realistic simulation that

was less-stressful than a real assessment in a clinical setting. Students also found the feedback to be more targeted at their performance by the instructor in debriefings (Corrigan et al., 2011).

In their findings, Corrigan et al. (2011) found that allowing students to reflect and evaluate their recordings in a group setting allowed for improved overall evaluation and discussion during the debriefing. The use of audio-visual feedback was an effective learning methodology. Using simulation in the performance of a simulated practical exam was very effective and similar to the interaction that would be experienced within the clinical setting (Corrigan et al., 2011). Could this apply to the initial education of paramedics?

In a 2004 study, Wyatt et al. examined the use of clinical simulations in trauma education for paramedics prior to entering the clinical setting. They studied the use of clinical simulation to reduce errors in the treatment of trauma patients. They found that using clinical simulations in paramedics reduced errors in both novice and seasoned paramedics. In novice paramedics, there was a greater reduction in errors with a recommendation for its use in paramedic initial training programs (Wyatt et al., 2004).

In Blair Lindsay's (2006) study using high-fidelity healthcare simulation to improve paramedic critical-thinking skills, he found that high-fidelity simulation could substantially enhance student critical-thinking skills, improve technical skills and confidence, and improve communication skills. He also found that high-fidelity healthcare simulation was superior in accomplishing the above as compared to low-fidelity or task-trainer-based simulators. He also found that high-fidelity simulation learning linked acquired cognitive knowledge to skills and medical practice in a way that

was not seen in the past (Lindsay, 2006). Similar to Lindsay, Massias (2009) quantitatively compared the effectiveness of simulated hospital experiences against traditional hospital experiences for her second-year obstetric nursing course. She found that “simulation is at least as effective as traditional clinical experiences in promoting critical thinking” (Massias, 2009, p. iv). Many of the findings which Lindsay and Massias found in their separate research directly apply to the teamwork issues identified in healthcare studies (Baker, Beaubien, & Holtzman, 2006). Both of these studies suggest the potential positive aspects of high-fidelity simulation use in initial paramedic education.

Francesca Brown (2011) studied the debriefing segment of simulations to investigate whether or not reflective learning principles were in use by the facilitators in nursing debriefings. She also studied their methods used to learn and evaluate the practice of facilitating debriefing following a simulation. Brown interviewed and observed nursing faculty beliefs and practices regarding debriefing in high-fidelity healthcare simulations. She found that there was great variability in how debriefings were conducted by nursing faculty especially when using Socratic questioning to facilitate reflection. Nursing facilitators did not utilize formal routine methods for evaluating their actions in the debriefings. Her recommendations included using student feedback to improve debriefings and structuring debriefings so that they supported the desired purpose of critique and reflection (Brown, 2011). Brown’s recommendations in this study have direct linkage to my work and were implemented to improve the quality and consistency of the debriefings.

Maria Overstreet (2009) also studied the debriefing segment of nursing clinical simulation debriefing. Overstreet observed four simulation dates in which six different educators at four different nursing schools were observed conducting simulations. While Overstreet videotaped the simulation and debriefings, the actual video was used by her only for the purposes of her study. It was not used in replaying the events of the simulation to the learners. No video recording of the students' performance in simulation was used in any of the debriefings. The simulations were conducted by four different educators in four different areas of nursing: medical/surgical, psychiatric, critical care (emergency room), and an emergency room/intensive care unit. Educators had between one half and 2 years of simulation experience and up to 3 years in conducting debriefings. In addition, they had varying levels of clinical experience in nursing practice ranging from 0.5 to 34 years. Students observed ranged from three to seven students in each of the four groups. Overstreet wanted to study the communication, structure, time/timing, and emotions experienced during the simulations by students. After analyzing the data she had collected, patterns emerged which suggested her findings.

Among the confirmed findings from previous research, Overstreet (2009) found that good debriefing facilitation involved the use of good listening skills on the part of the facilitator/debriefer and the use of questions which caused the students to examine their actions. This reflective part of debriefing was confirmed from previous studies within her theoretical framework based on the theories of Dewey, Kolb, and Schön. These theories formed a conceptual framework for my study.

Overstreet also found that some of the facilitators engaged in negative feedback regularly as part of their debriefing. Often this would result in confronting learners in a

demeaning manner. One facilitator was observed stating to a student group, “You finally did some vital signs on her [the simulated patient] and which no one got a temperature” (Overstreet, 2009, p. 58). This same action could have been done in a more reflective and positive way during the debriefing.

Overstreet (2009) found that timing in the recognition of teachable moments by the facilitators was also observed by the researcher as a positive aspect in debriefing. Student actions create windows in which the facilitators can enter new information into the students’ thought process during these teachable moments. The use of timing by facilitators can allow for more effective reflection by students.

In her study, Overstreet (2009) also found some new patterns in her research which she was unable to find in the previous studies. These were: (a) to accentuate the positive, (b) generate higher order thinking, and (c) that the experience of the educators counts. Each of these was important in the facilitation of simulation debriefings.

In providing feedback, educators may focus on the negative aspects of a performance while not reinforcing the positive aspects. In Overstreet’s (2009) findings, accentuating the positive describes facilitators highlighting the good or correct things that were done by the students within the simulation. By doing this, it gives the student a more rounded feedback resulting in better learning. One of the student comments from a simulation where negative feedback was heavily used was, “It showed that I still have a lot to learn when it comes to nursing care in emergency situations” (Overstreet, 2009, p. 60). This and other student comments suggest less confidence in their knowledge as a result of simulation.

Higher order thinking involves the student assembling the different facets of learning into one congruent operation applied to a clinical case. Overstreet (2009) presented several quotes describing this process from her students: “‘pull everything together and make sense of it all’, ‘debriefing just put all the pieces of the puzzle together’, ‘I think it [debriefing] is the most important part of the sim lab’” (Overstreet, 2009, p. 87). Overstreet coined this as “putting it all together” within her study.

The experience of the clinical educator in facilitating a debriefing was pivotal to creating a conducive student learning environment. Facilitators with more experience were directly able to link in debriefing the student experiences in simulation to actual field experiences they shared with students. Facilitators who lacked experience were less likely to link student simulation experiences to actual nursing experiences encountered in the field.

The fidelity in the level of simulation varied in Overstreet’s (2009) observations. She commented about one of the simulations:

The visual realism for this simulation was minimal. Visible to the students was Educator 1 who was seated beside the simulator’s computer as she altered mannequin values. The voice of the patient came directly from Educator 1, and students looked at her, not the patient, as they asked questions to the simulated patient. The physical environment had few props to suggest an emergency department, it was evidently a classroom setting. Extraneous equipment and posters also distracted from realism. Students were responsible for using their imagination to make the simulation exercise believable. (Overstreet, 2009, p. 56)

The setting utilized in the simulation was a classroom converted to a hospital environment. It was unclear whether or not the lack of fidelity translated into improved, decreased or the same level of learning as higher fidelity simulation.

Overstreet’s (2009) study has direct application to mine. She reinforced the need to provide a positive environment for debriefing which was supportive to reflective

learning. Active listening must be employed by the facilitator if they are to understand and address the students' need to understand their experience. The debriefing methods employed should include positive feedback and allow students to understand what knowledge they know or don't know. These was applied to my methodology in debriefing.

In reviewing previous studies related to this study (Baker et al., 2006; Brown, 2011; Clendinneng, 2011; Conejo, 2010; Cook et al., 2012; Corrigan et al., 2011; Kuznar, 2009; Lindsay, 2006; Massias, 2009; Overstreet, 2009; Van Horn, 2000), some general themes emerge:

1. Using simulated experiences can transfer learning from the classroom to the clinical environment.
2. Simulation allows the practitioner to control what is learned in the simulation experience. Within the clinical setting, experiences are difficult to control.
3. Students viewing their performance on video can result in greater learning and change their future behavior.
4. A facilitator to review performance is often necessary to identify and correct poor performance.
5. For simulation to be effective, a safe learning environment must be created that allows students to make mistakes without future penalty. Likewise, simulation provides a risk-free environment for students to practice compared to the actual clinical setting where repercussions for errors can be substantial.
6. High student-to-instructor ratios in simulation may be detrimental to learning.

7. Prior to simulations, students must be prepared for what they will encounter and how they are expected to behave.

8. During debriefing, it is more effective to use pre-identified clips of the students' performance and use these as a springboard for discussion regarding their performance.

These studies suggest the viability of simulations, audio-video recordings, instructor feedback, and debriefing as crucial instructional practices in clinical education for healthcare personnel. The next section will outline the context for paramedic education and its clinical, teamwork, and leadership development.

### **EMS Paramedic Education Requirements**

To understand the education requirements for becoming a paramedic, I must first provide some background on the EMS System. Following that, I will discuss levels of licensing before discussing specific information on paramedic training program requirements. This allows for a better understanding on current paramedic education and the problems associated with it.

#### EMS System

The National EMS System was established following the National Academy of Sciences publication of *Accidental Death and Disability: The Neglected Disease of Modern Society* (1966). This pivotal study documented dismal conditions which faced Americans who became injured or ill prior to being received at a hospital, sometimes called *pre-hospital* care. "Expert consultants returning from both Korea and Vietnam have publicly asserted that, if seriously wounded, their chances of survival would be



better in the zone of combat than on the average city street” (National Academy of Sciences, 1966, p. 12). Approximately 50% of all ambulance services were provided by morticians with little or no additional training, mainly because their vehicles could accommodate stretchers. This study also pointed out the financial and human losses to society as a result of these injuries and deaths. The recommendations of this report formed the basis for the Nation’s first organized modern Emergency Medical Services system (Brennan, Krohmer, & American College of Emergency Physicians, 2005; Post, 2002).

Following the publication *Accidental Death and Disability: The Neglected Disease of Modern Society* (National Academy of Sciences, 1966), formal EMS Systems were established through Federal and State efforts that included (a) the clinical elements of first aid, CPR and out-of-hospital interventions; (b) legislative efforts which gave funding, legal control and public access (9-1-1) to the systems; (c) system design/development which included physician oversight/training, personnel training/education, public/media education, easy access, ambulance design, and data collection/analysis/research (Brennan et al., 2005). These systems were often designed based on successful military or public service models (Foster, Goertzen, Nollette, & Nollette, 2011).

#### Levels of Certification/Licensing

Within the United States, at the national level, there are four levels of training for EMS personnel. These are—from least to greatest in hours in training—the Emergency Medical Responder (EMR), Emergency Medical Technician (EMT), Advanced Emergency Medical Technician (AEMT), and Paramedic (NHTSA, 2009). Within

Michigan, licensing is used for all four levels. While national certification is done through the National Registry of Emergency Medical Technicians (NREMT), licensing also may be required by individual states, often based on the certification. Formal NREMT certification usually requires that a written and practical skills evaluation be conducted at a formal testing center after students are recommended by accredited schools offering EMS education and training. The licensing levels in Michigan are Medical First Responder for the national level of Emergency Medical Responder Certification and Emergency Medical Technician Specialist for Advanced Emergency Medical Technician Certification. EMT and paramedic levels are the same terms for state licensing and national certification (State of Michigan, 1990).

The paramedic is the highest level of EMS Personnel routinely working on the ambulance. The training and education of a paramedic requires 1,000-1,200 hours of education beyond the Basic EMT prerequisite (NHTSA, 1998). This education is provided utilizing didactic, practical and clinical education, but individual states can adopt or implement curriculums of their choosing.

### Protocols

All EMS personnel operate under protocols, which define what actions they can take before and after contact with a physician. The protocols are guided by the National Scope of Practice Model, which defines the normal minimal scope of practice for an EMS provider. As the highest level of care, paramedics perform all Basic Life Support (BLS) techniques, perform assessments on patients, administer oxygen with various devices including positive pressure airway assist devices, insert endotracheal tubes, insert other advanced airway tubes, administer medications, start infusions of intravenous

fluids, insert intraosseous cannulas, perform percutaneous cricothyrotomy (using a needle to create an airway), decompress air trapped between the lung and chest wall, insert gastric tubes, manage emergency conditions, perform 12-lead electrocardiograms, monitor blood sugar, obtain pulse oximetry, monitor end-tidal carbon dioxide levels, perform extrication and spinal immobilization, control bleeding, and more (NHTSA, 2006). The expectation is that a paramedic can manage most emergency medical situations with a high level of autonomy. Most life-saving procedures or medications are administered by the paramedic prior to contact with a physician based on the patient's critical medical need as part of their autonomy in practice (NHTSA, 2006; Post, 2002).

### Paramedic Curriculum

In Michigan, the paramedic curriculum is based on the U.S. National Curriculum. The paramedic level requires 500-600 hours of didactic and practical instruction. In addition, it requires 250-300 hours of clinical experiences, and 250-300 hours of field internship (State of Michigan, 2006). The clinical experiences must be during the time that practical and didactic instruction is occurring. The field internship is the last phase of education prior to certification. Students must have completed all didactic, practical, and clinical instruction prior to starting the field internship (State of Michigan, 2007).

### Competencies

Students who participate in the clinical experiences and clinical internship must demonstrate proficiency in skills or competencies. All of the skills must be demonstrated by the student with an observed successful evaluation at least once. However, they are also recommended to be repeated in practice on live or simulated patients a number of

times. The competency may also indicate treating a patient with that particular condition.

The competencies, along with the minimum recommended number, are as follows:

Abdominal Assessment (20), Adult Assessment (50), Adult Dyspnea (20), Altered Mental Status (20), Chest Pain Assessment (30), Endotracheal Intubation (5), Geriatric Patient (30), Medication Administration (15), Obstetric Patient (10), Pediatric Dyspnea (8), Pediatric Assessment (30), Psychiatric Assessment (20), Team Leader (50), Trauma Patient (40), Unintubated Ventilation (20) and Venous Access (30) (NHTSA, 1998; State of Michigan, 2007).

It is known that programs may have difficulties obtaining competencies in clinical or internship settings (Salzman et al., 2007). Clinical experiences vary from program to program but should follow the Paramedic National Curriculum (NHTSA, 1998).

Depending on the program, available clinical experiences will vary. For example, it is known that difficulty obtaining live human intubations, usually performed in the hospital operating room under direct supervision of an anesthesiologist or nurse anesthetist, can be difficult to obtain (Johnston, Seitz, & Wang, 2006). As stated in the Michigan Paramedic Curriculum, "If the program is unable to achieve the recommendations on live patients, alternative learning experiences (simulations, programmed patient scenarios, etc.) can be developed" (State of Michigan, 2007, p. 153). The use of simulation, as a practice to obtain the recommended number of competencies as well as evaluate the practice of a competency, is allowed within the education standards and can be directly linked to future student success.

It is also known that the quality and number of patient contacts that the paramedic student is exposed to within their clinical internship has a direct correlation with the

likelihood of their passing the National Registry Paramedic Written Examination (Salzman, Dillingham, Kobersteen, Kaye, & Page, 2008). In the 2008 Salzman et al. study, there was a direct correlation between cognitive exam results on the National Registry Paramedic cognitive exam and the number of ALS runs experienced in the clinical internship. Paramedic high-fidelity healthcare simulation in Australia has been successfully used to decrease errors and improve the performance of paramedics graduating from a bachelor's degree paramedic program (Boyle, Williams, & Burgess, 2007). The Studnek, Fernandez, Shimberg, Garifo, and Correll (2011) study, performed in Charlotte, North Carolina, confirmed a direct relationship between simulation-based field performance by paramedics and improved scores on cognitive exams (Studnek et al., 2011). This suggests a direct linkage in the use of high-fidelity simulation in potentially improving the quality and reducing errors in paramedic graduates of programs using this methodology.

There are concerns with the definitions for minimal competencies within the paramedic program. While minimum competencies are defined, they do not require exposure to critical problems or sentinel events. By their nature, sentinel events would be difficult to control in a clinical setting, since they are infrequent by definition. Yet does this best prepare the paramedic to experience these once they have graduated? There are many examples of this in the paramedic curriculum. The obstetrics competency states, "The student must demonstrate the ability to perform a comprehensive assessment on at least 10 obstetric patients" (State of Michigan, 2007, p. 154). There is nothing that states whether or not the obstetric patient is in labor, is displaying a life-threatening condition,

or the time of gestation. Similar definition problems exist for nearly all patient types that are presented within the paramedic competencies.

### Leadership in EMS

Formal leadership education or training is minimal within the paramedic curriculum. There are no leadership theories presented as part of the education process. Within the Michigan *Requirements for Paramedic Education Program* document, the term *leader* is mentioned 13 times and leadership none (State of Michigan, 2007). When it is mentioned, it is in the context of the leader's actions, but not part of a structured training program. At the national level, the *Paramedic Instructional Guidelines* (U.S. Department of Transportation, 2009) mention leader twice and leadership once. Where *leadership* is mentioned, a brief outline under Leadership Characteristics includes attributes, skills and abilities, communication, time management, teamwork and diplomacy, respect, patient advocacy and delivery of service (U.S. Department of Transportation, 2009). In addition, within the older *EMT-Paramedic: National Standard Curriculum* (NHTSA, 1998), *leader* is mentioned 38 times within a context of being a team leader, not the specific skills needed to be a team leader.

In *Introduction to Advanced Prehospital Care*, one of the most common textbooks used for instruction at the paramedic level, the authors state, "Leadership is an important but often forgotten aspect of paramedic training. Paramedics are the pre-hospital team leaders. . . . They must develop a leadership style that suits their personalities and gets the job done" (Bledsoe et al., 2008, p. 94). They go on to describe some characteristics of a successful leader with no further information on how to become a leader.

In *Foundations of Paramedic Care*, authors dedicate a page and a half to the need for leadership. Horizontal rather than vertical leadership is discussed along with a definition of organizational competence. “The qualities of a good leader can be summed up in the five C’s: competence, command presence, choreography, communications, and conflict resolution” (Beebe & Myers, 2009, p. 11). Within the competence quality, situational awareness is discussed as a component. In their final paragraphs, they discuss the principles of followership, which the paramedic must demonstrate as both a leader and a follower, depending on their specific role (Beebe & Myers, 2009).

In Chapter 5 of *The Paramedic*, elements of leadership such as critical thinking and situational awareness are discussed, but the actual term *leader* was not used. No section on leadership was found within the 1,426-page text nor was it mentioned in the index (Chapleau, Burba, Pons, & Page, 2011). This is also true in the textbook *Emergency Care in the Streets*, which is another popular paramedic textbook. While there is a small section involving some concepts in leadership, there is no summation or event methodology in either textbook which discusses the process of leadership and methods for success (Caroline, 2010).

In juxtaposition, State of Michigan Public Act 179, Section 20967, states,

Authority for the management of a patient in an emergency is vested in the licensed health professional or licensed emergency medical services personnel at the scene of the emergency who has the most training specific to the provision of emergency medical care. (State of Michigan, 1990, Section 20967[1]).

In essence, the leadership role for the medical management of the patient is given to the highest trained emergency medical personnel on the scene. Yet, within the state and federal education curriculums and textbooks, formal leadership education is sparse.

So, how is leadership taught in paramedic education programs? The current methodology for scene leadership education is based on a hierarchical model in which the highest level licensed individual on scene is responsible for the patient. Additional teamwork methodologies to aid the leader are emerging from related courses such as the American Heart Association Advanced Life Support and Pediatric Life Support courses that are often embedded within the paramedic initial education. However, numerous studies and books have suggested that a strict hierarchical model devoid of excellent teamwork skills may not be the best methodology for medical practitioners (Baker et al., 2006; Cannon-Bowers & Salas, 1998; Deering et al., 2009; King et al., 2008; LeSage, Dyar, & Evans, 2011; Nance, 2008; Sexton et al., 2000). In fact, these studies suggest that a strict hierarchical model may actually contribute towards more medical errors.

#### Medical Error Training and Leadership

The National and Michigan paramedic curriculums teach a number of specific practices that help to decrease medical errors. The methods of error control are usually based on long-identified practices developed within the hospital settings. Other allied health professions have developed courses to teach patient safety/medical error training within their professions (Wilson, Fabri, & Wolfson, 2012), and safe practice methodologies in procedures are part of the core paramedic education curriculum. Despite this, medical errors by paramedics and other healthcare professions continue to occur (Kohn et al., 2000). Within EMS, there is a paucity of research investigating the judgment and decision-making process for paramedics (Shaban, Wyatt Smith, & Cumming, 2004). This decision-making process can directly lead to increased medical errors.



Reason (1990, 1997) has done a great deal of work exploring the concept of errors and their direct application to high-risk industries including medicine. Regarding a specific classification scheme, Reason states:

There is no universally agreed classification of human error, nor is there one in prospect. A taxonomy is usually made for a specific purpose, and no single scheme is likely to satisfy all needs. Nearly everyone who has published in the field has devised some form of error classification. (Reason, 1990, p. 10)

Despite the lack of a specific classification system, there are terms and concepts which are useful in defining errors and their causes.

One important distinction in terms of errors is whether or not the error is latent or active in its origin. Latent errors are those which are caused by systems or organizational policies or procedures which created a potentially unsafe condition. An example of this would be performing venipuncture without a safe sharps container to dispose of the used needle. A loose needle is a source for further injury to patients or healthcare workers. This is in contrast to active errors which are caused by the direct action of an individual. An example of an active error would be an individual choosing an incorrect diagnosis for a patient following their examination (Reason, 1990, 1997). In examining errors made by paramedics within simulations, this distinction is important. It is possible that both forms of errors may be observed within simulations.

Active errors can further be subdivided into a number of causes. Several studies have used terminology to describe the actions observed by students in simulation and as practitioners in practice making cognitive errors. There is no definitive universally set of error terms which were found; however, there was agreement in some of the terminology between several of the studies. Since a terminology to describe the student errors observed in this study is needed, a summary table was constructed based on the works of

several authors. Table 1 presents a summary of the cognitive error terminology and related concepts that may also pertain to pre-hospital medicine (Borrell-Carrió & Epstein, 2004; Croskerry, 2003; Graber, Gordon, & Franklin, 2002; Kempainen, Migeon, & Wolf, 2003; M. A. Stiegler, 2010; M. P. Stiegler, Neelankavil, Canales, & Dhillon, 2012). It should be noted that Table 1 does not represent all of the possible cognitive errors, only those that are more likely in pre-hospital medicine. Also, where terms and concepts were similar, a term was selected to represent that concept. Alternate terms were given along with the specific study in which they originated.

Active Errors are caused by a number of different factors when attempting to form a diagnosis of a patient's condition. These errors occur in the steps of perception of the patient, hypothesis generation based on observations, data interpretation from diagnostic tests and measureable findings, and verification of diagnosis by additional testing and review (Graber et al., 2002). Correcting the cognitive process, in which the clinician deviated from the correct diagnosis, must start with an understanding of how and why they chose their diagnosis (Schön, 1987; Westberg & Jason, 2001). This information is important to my study since identification of the specific error a student makes along with an exploration of the reason for their error through reflection may change their future practice as described by Schön (1983, 1987) and Kolb (1983; Kolb et al., 2001).

Table 1

*Cognitive Errors Observed in Medical Practice*

Error Term	Description
Anchoring	A premature lock on a patient diagnosis based on initial presentation and failing to change that diagnosis once later contradictory or non-supportive information is obtained. Some studies have called this error Anchoring and Adjustment (Kempainen et al., 2003, p. 179).
Ascertainment bias	Occurs when the practitioner's thinking is shaped by prior expectation. Stereotyping and gender bias are examples.
Availability bias	The desire to diagnosis a disease because of a recent experience causing an expectation of seeing that disease or the inability to diagnosis based on the rarity of seeing it.
Commission bias	Occurs when the practitioner's belief that harm will result to the patient by a lack of action rather than no further harm by inaction. These situations often result from overconfidence, desperation, or pressure from others affecting the practitioner.
Confirmation bias	The tendency for the practitioner to look for confirming evidence to support a diagnosis rather than disconfirming evidence to deny it. Also called Pseudodiagnosticity (Kempainen et al., 2003, p. 179).
Diagnosis momentum	Once a possible diagnosis is attached to a patient by earlier providers or caregivers, the consistent repeat of that possible diagnosis cements to become the actual diagnosis, ruling out all other possibilities, regardless of the facts.
Feedback bias	The misinterpretation of no feedback as positive feedback by the practitioner. This is linked to unintentional awareness (Stiegler et al., 2012, p. 230).
Framing effect	The signs, symptoms, and other manifestations of a patient start building a framework for a common diagnosis; however, in doing so, less common diagnoses are overlooked. This is also known as representativeness restraint. "If it looks like a duck, walks like a duck, quacks like a duck, then it is a duck" (Croskerry, 2003, p. 778). There is also Sutton's slip which is closely related to this error. Sutton's slip got its name from the story of the Brooklyn bank robber Willie Sutton who when asked by a Judge why he robbed banks, he replied, "Because that's where the money is" (Croskerry, 2003, p. 778). Once again, performance of this error can cause lock-out of any other potential causes. This is also known as judging by similarity.
Omission bias	A decision to not take action based on the concept of doing no further harm. However, in critical situations, the lack of action may result in additional harm to the patient.
Overconfidence bias	A tendency for the practitioner to believe they know more than they actually do. Often this relies on intuition, hunches, or a desire to act on incomplete information. Anchoring and availability bias both may be involved with this.

Table 1–Continued.

Error Term	Description
Playing the odds	The tendency for the practitioner to determine and treat a diagnosis based on its commonality of presentation rather than to screen for a less common diagnosis. This is also known as the “Zebra Retreat” (Stiegler et al., 2012, p. 230) or “Frequency Gambling” (Croskerry, 2003, p. 778).
Posterior probability error	The tendency for the practitioner to misdiagnose a condition/disease because of previous patient presentations or diagnosis. In these previous presentations, similar signs/symptoms resulted in the same diagnosis each time. As a result, the bias is towards the same diagnosis again rather than ruling out other potential causes.
Premature closure	The practitioner’s decision to prematurely determine a diagnosis excluding other possible causes. A common maxim is “when the diagnosis is made, the thinking stops” (Croskerry, 2003, p. 778).
Psych-out error	Psychiatric patients presenting medical symptoms are discounted due to their psychological condition resulting in wrong medical diagnosis. A belief is that they are not actually presenting actual symptoms or that their psychological crisis or manifestations cover the actual symptoms presented.
Search satisfying	The tendency to call off the search once something is found leading towards a diagnosis. As a result, additional information is missed that could lead towards a different diagnosis. Also, if nothing is found within a search, the search may be prematurely ended without looking for additional causes. Also known as Bounded Rationality (Kempainen et al., 2003, p. 179).
Sunk costs	The more a practitioner invests in a diagnosis in terms of ego, treatment, and time, the harder it is to change that diagnosis or look for other alternatives. Confirmation bias also may be involved in this error.
Unpacking principle	A failure to obtain or consider all relevant information when establishing the differential diagnosis. The missing information may be the pertinent information which changes the diagnosis.
Visceral bias	An affective domain-based bias on the part of the practitioner towards the patient due to negative or positive feelings. As a result of these feelings, the practitioner may ignore potentially catastrophic diagnosis in favor of less severe diagnosis, which they favor. This has also been described as a fundamental attribution error as a result of countertransference.

Note. Derived and adapted from "Preventing Errors in Clinical Practice: A Call for Self-Awareness," by F. Borrell-Carrió and R. M. Epstein, 2004, *Annals of Family Medicine*, 2(4), 310-316; "The Importance of Cognitive Errors in Diagnosis and Strategies to Minimize Them," by P. Croskerry, 2003, *Academic Medicine*, 78(8), 775-780; "Reducing Diagnostic Errors in Medicine: What's the Goal?," by M. Graber, R. Gordon, and N. Franklin, 2002, *Academic Medicine*, 77(10), 981-992; "Understanding Our Mistakes: A Primer on Errors in Clinical Reasoning," by R. R. Kempainen, M. B. Migeon, and F. M. Wolfe, 2003, *Medical Teacher*, 25(2), 177-181; *Anesthesiologists' Nontechnical and Cognitive Skills Evaluation Tool*, by M. A. Stiegler, 2010, University of California, Los Angeles, CA: Center for Educational Development and Research; "Cognitive Errors Detected in Anaesthesiology: A Literature Review and Pilot Study," by M. P. Stiegler, J. P. Neelankavil, C. Canales, and A. Dhillon, 2012, *The British Journal of Anaesthesia*, 108(2), 229-235. If a different terminology was found in only one source, that source is identified within the description column.

Another important distinction is the intention of the action. Intentional action based errors are caused usually by either following a rule that does not apply or by a knowledge-based mistake. In contrast, unintentional actions can be caused by failures in recognition, inattention, memory mistakes, or poor selections. A violation error is one that is often caused by routine or cutting corners, optimizing violation caused by boredom or distraction, and situational violations. Situational violations occur when only one path is evident to complete a task; however, it is inappropriate for that specific situation (Reason, 1990). Figure 1 shows an algorithm identifying those errors and a methodology for differentiation.

It is known that these errors often can be identified through the use of teamwork skills in which an aware team member intercedes on the behalf of the team leader or individual committing the error (Baker et al., 2006; King et al., 2008). However, all team members must be trained in this practice. As part of my research, identifying the types of errors committed by students in a high-fidelity simulation may be of benefit in understanding exactly what and how they learn.

Research has found that a number of specific paramedic errors continue to occur in the pre-hospital arena. Endotracheal tube placement continues to be a known error source in EMS (Katz & Falk, 2001; Thomas, Abo, & Wang, 2007; Wang, Lave, Sirlo, & Yealy, 2006). Incorrect drug dosage calculations (R. Lammers, Byrwa, & Fales, 2012; R. L. Lammers, Byrwa, Fales, & Hale, 2009; LeBlanc, MacDonald, McArthur, King, & Lepine, 2005) and subsequent errors in medication administration continue to be noted in EMS studies (R. Lammers et al., 2012; R. L. Lammers et al., 2009; Vilke et al., 2006). Stress is known to be a contributor to errors by paramedics (LeBlanc et al., 2005; Palmer,

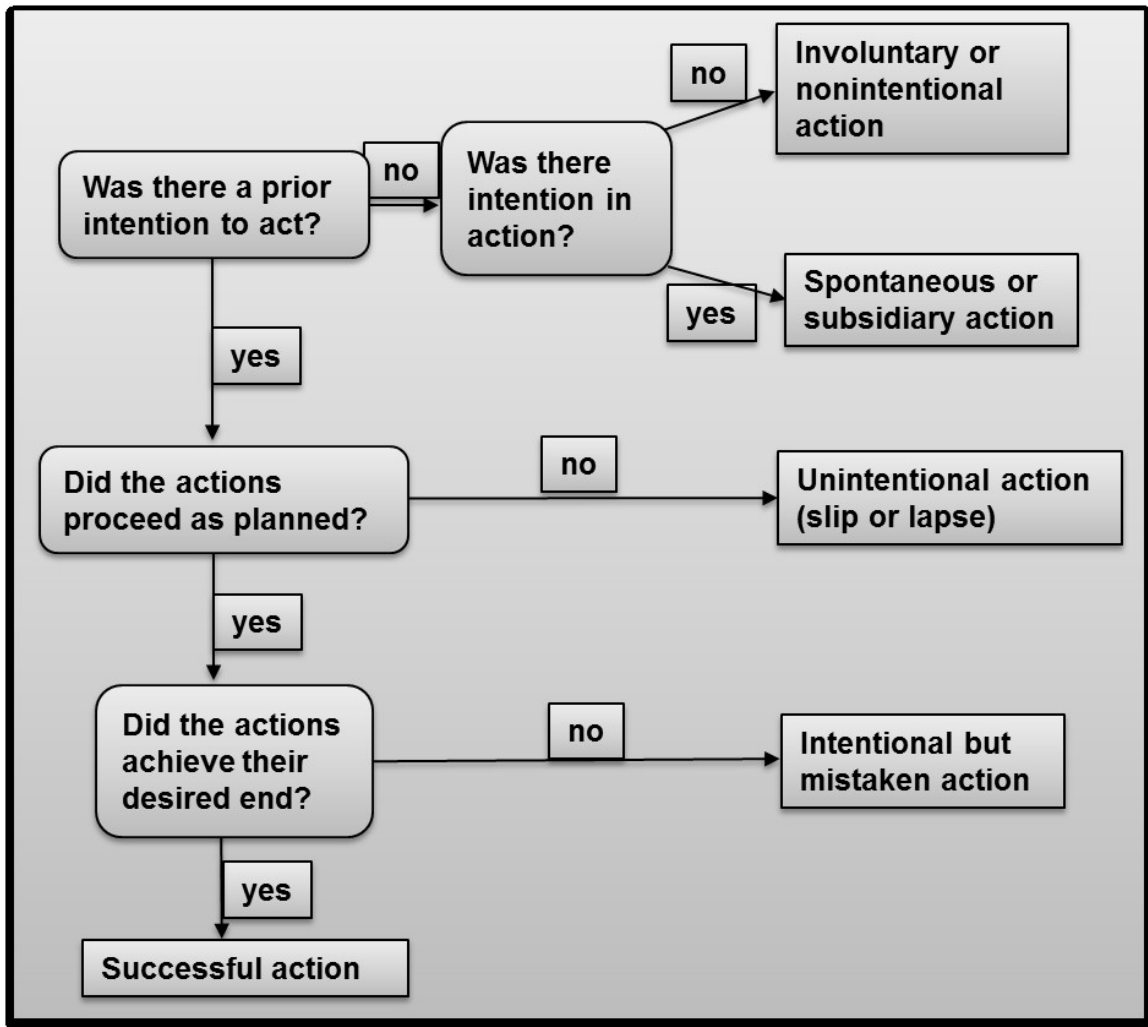


Figure 1. Algorithm for distinguishing behavior varieties that result in human errors. From *Human Error* (p. 6), by J. Reason, 1990, Cambridge, United Kingdom: Cambridge University Press. *Note.* Errors observed can be sorted into different categories based on intention, outcome, and actions.

1989). There are many sources for errors; however, simulation has been identified as one methodology that can help to identify and mitigate these errors (R. Lammers et al., 2012). In other areas of medicine, teamwork programs such as *TeamSTEPPS* have been found to help reduce these errors (King et al., 2008).

In their 2009 study, “Simulation-based Assessment of Paramedic Pediatric Resuscitation Skills,” Lammers et al. found that 212 practicing licensed paramedics

committed multiple errors in the treatment of three separate simulated pediatric patients in sepsis/seizures, child asthma/respiratory arrest, and infant cardiac arrest. These errors included incorrect or no use of the Broselow measuring tape, incorrect calculation and administration of medications and fluids, deficiencies in performance of resuscitation skills, and lack of airway/ventilatory and cardiac support. A recommendation from this study was for educators and EMS medical directors to target these specific skill deficiencies when developing pre-hospital continuing education (R. L. Lammers et al., 2009). This recommendation was based on previous research indicating up to a 50-61% loss of skills proficiency 2 years after initial education (Latman & Wooley, 1980). It is important that initial education does provide these initial skills at a high proficiency. Pediatrics is a known area where there may be a limited availability of clinical sites available for paramedic education programs (Dawson, Brown, & Harwell, 2003).

The significance and impact of human errors has been documented in many studies and books over time. *To Err Is Human* (Kohn et al., 2000) presents the statistical facts and figures as a result of human error in medicine. For individual stories, another book, *Wall of Silence*, presents the human side with stories of medical errors. Authors Gibson and Singh (2003) write:

Those who bear the consequences of medical mistakes—and their families—carry a burden that is in no way reflected in the grim statistics. For some, a part of who they are is literally gone as a result of surgical or other mistakes. For others, their families' only memories of a loved one, and the ache in the heart of survivors is palpable. The rage is like a rising tide ready to wash away everything in its wake. Fear reigns among those who have vowed to stay as far away as possible from the system that harms. (Gibson & Singh, 2003, p. xvii)

While the above books present in great detail the problems of errors in medicine, *Why Hospitals Should Fly* (Nance, 2008) and *Charting the Course* (Nance &

Bartholomew, 2012), by military pilot, safety expert, and attorney John Nance, suggest many of the solutions in a model that could change the face of medicine, if applied.

Nance describes a new paradigm for medicine which is more of a patient-centered, shared leadership and collaborative process between the patient and all healthcare workers involved in their care. As part of the model, it rejects the current hierarchical leadership model and suggests changing the culture of medicine to maximize care and minimize the costly medical errors in this high-risk industry. Many of his concepts, including changing the culture of medicine, have direct application to the pre-hospital environment and are part of team-training programs such as *TeamSTEPPS*.

In this section, I have shared the current context for paramedic education and the conditions by which current practice occurs. I identified a number of problems which are present in the current paramedic education model and their impact on patients. While these problems are not unique to EMS, application of some of the solutions found in related specialties and industries may be. The next section discusses with how teamwork skills in healthcare evolved following some of the recommendations of *To Err Is Human* (Kohn et al., 2000). The starting point of excellent leadership is knowledge in fundamental teamwork skills by its members.

### **Learning Teamwork**

In *To Err Is Human* (Kohn et al., 2000), one of the recommendations that was made to reduce the number of human errors was to pattern medical practices after other high-risk industries such as nuclear power, chemical production, and the airline industry. Earlier in 1987, research at the Stanford Simulation Center began the process of implementing simulation to train anesthesiologists using preprogrammed scenarios in a



simulated operating room. These scenarios utilized crews, which were defined as from one healthcare discipline working with other crews, from a different discipline, to form teams. Some of the first teamwork training involving simulation began in this process. Much of this training was based on lessons learned from Crew Resource Management, a system for preventing airline transportation accidents. In fact, several of the simulation-based studies cited in *To Err Is Human* were published as a result of this research (Kohn et al., 2000). The next decade would show an expansion of this Anesthesia CRM (ACRM) curriculum at other teaching institutions (Gaba, Howard, Fish, Smith, & Sowb, 2001).

In 2006, the Department of Defense performed an independent case study analysis of medical team-training needs within the United States. Among their recommendations were the need to standardize the knowledge, skills, and attitudes towards medical team training and to identify practice-specific training requirements for teams (Baker et al., 2006). This work would lead to the development of a program called TeamSTEPPS. While not currently a specific part of the paramedic curriculum, TeamSTEPPS is rapidly being used in medical practice and hospitals to reduce medical errors. In the following section, I will explain the origins and connections between TeamSTEPPS and the aviation equivalent of Crew Resource Management (CRM).

### **TeamSTEPPS/CRM**

TeamSTEPPS is an acronym for Team Strategies and Tools to Enhance Performance and Patient Safety. TeamSTEPPS first began as a research program in 1998 by the Federal Agency for Healthcare Research and Quality (AHRQ), whose mission under the United States Department of Health and Human Services is to improve the

quality, safety, efficiency and effectiveness of healthcare for all Americans. This research program, in collaboration with the United States Department of Defense, studied safety and organizational culture healthcare agencies utilizing experts in Crew Resource Management training experience (King et al., 2008). In 2000, the Institute of Medicine (IOM) publication *To Err Is Human* recommended that medical errors and omissions could be reduced through the use of techniques found in other high-risk industries such as Airline Transportation, Chemical Manufacturing, and Nuclear Power (Kohn et al., 2000). In essence, TeamStepps was the result of taking the lessons learned in the Airline Transportation Industries' Crew Resource Management (CRM) and applying them to medical practice.

Like the medical industry, the aviation industry was not always safe. From 1982 to 2006, the National Transportation Safety Board reported that there were 53 jet accidents which resulted in 2,180 fatalities worldwide. Seventy percent of these accidents were linked to the crew's failure to use all the available resources while in flight (Doucette, 2006). However, since the implementation of CRM, the accident rate, fatal accident rate, and related deaths were drastically decreased to zero in several different years. These decreased rates have occurred during a time in which the number of flights and passengers has continued to increase overall (Doucette, 2006; Matthews, 2004).

Crew Resource Management (CRM) was developed in the airline industry following a number of deaths that resulted from airline crashes while conducting their normal operations (King et al., 2008). On March 27, 1977, KLM Flight 4805 collided with Pan Am Flight 1736 at Los Rodeos Airport. This airport is located in the Canary Islands in the Spanish territory of Tenerife Island. This collision would earn the title of

the deadliest aviation accident in aviation history (Hebert, 2007). The collision of these two Boeing 747 aircraft claimed 583 lives due to preventable pilot error. Later, flight recorders and eyewitness testimony would indicate that the members of the crew of the KLM flight were aware of the danger, but the hierarchical structure and aviation culture did not allow for override of the captain's orders. As a result, their plane would begin their take-off not knowing that Pan Am Flight 4805 lay in the fog on the runway before them (Nance, 2008; Spanish Ministry, 1977).

Human errors and the presence of a hierarchical strict airline culture all contributed to the tremendous loss of life at Tenerife. Out of this accident emerged a new teamwork methodology (CRM) that replaced the strict hierarchical model with one that was quite different. CRM is more of a teamwork approach towards managing an aircraft with the use of cross-monitoring by team members and closed-loop communications to verify that situational awareness exists across the entire crew. This model utilizes positive and negative learning loops to improve team performance. In the positive learning loop (see Figure 2), good team performance results when crews are trained in CRM principles and practice that training in their behavior. However, if an accident or near-miss occurs, where a safety issue exists, then an accident analysis is done coupled with research to determine what methods can change or prevent a recurrence. The knowledge gained is then added to the training or retraining within the organization and it changes operational behavior resulting in continued good team performance and minimizing repeat accidents of similar cause (Flin et al., 2002). Many in healthcare industry see the pattern of a hierarchical culture from aviation being present within the medical model (Kohn et al., 2000; Nance, 2008; Nance & Bartholomew, 2012).

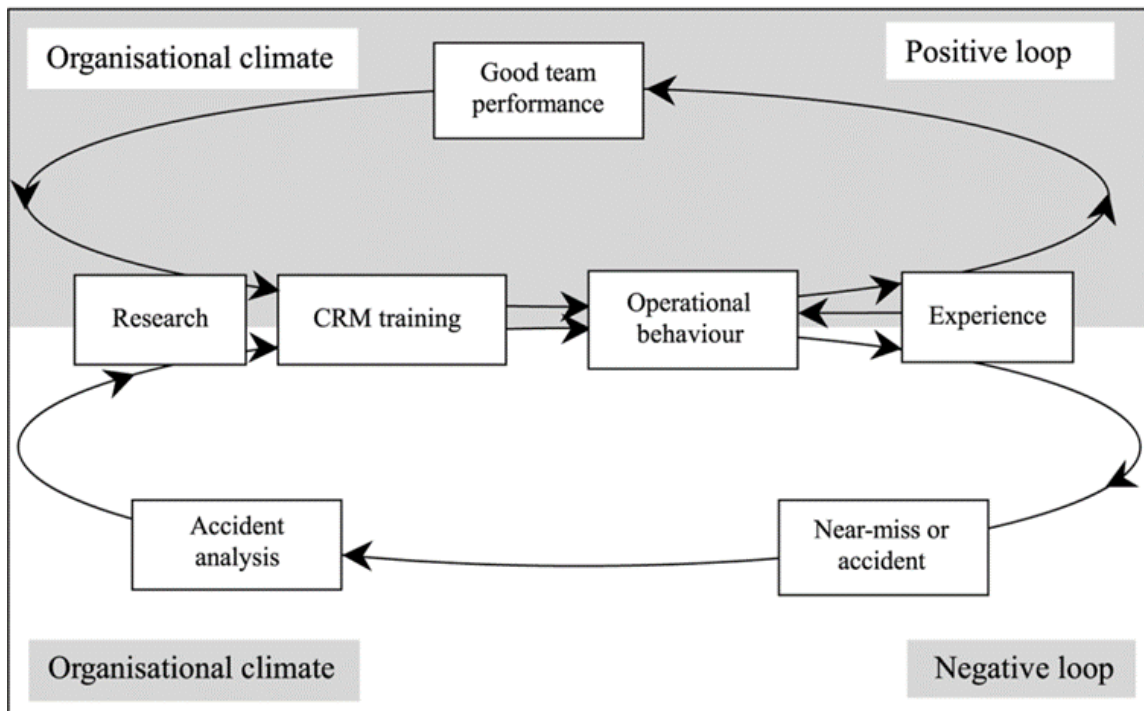


Figure 2. Negative–positive loop learning. From “Crew Resource Management: Improving Teamwork in High Reliability Industries” (p. 69), by R. Flin, P. O’Conner, and K. Mearns, 2002, *Team Performance Management*, 8(3/4), 68-78.

Within the third generation of CRM, there became an awareness of human factors and their implications for failures under stress. James Reason’s 1990 book *Human Error* describes a model of human error which has implications beyond the aviation industry. He describes what is referred to as the Swiss Cheese Model of Accident Causation seen in Figure 3. The Swiss Cheese Model uses latent failures or those which are precipitating factors or contributions to an active failure, where the implementation of a poor decision results in a negative impact. Each latent action is described as a porous piece of Swiss cheese. For an active failure to occur, an event must pass through the holes of each latent piece of cheese without impact. Only then can this event reach the end point where an active failure occurs (Reason, 1990).

Since the initial development of CRM, the system has continued to evolve and refine the concepts within it. The landing of Flight 232 in Sioux City, Iowa, by Captain Al Haines was considered to be a pivotal event that demonstrated how effective CRM can be. During this flight, the right engine suffered a massive mechanical failure resulting in explosion and shrapnel entering the aircraft's tail section, severing all controls. An off-

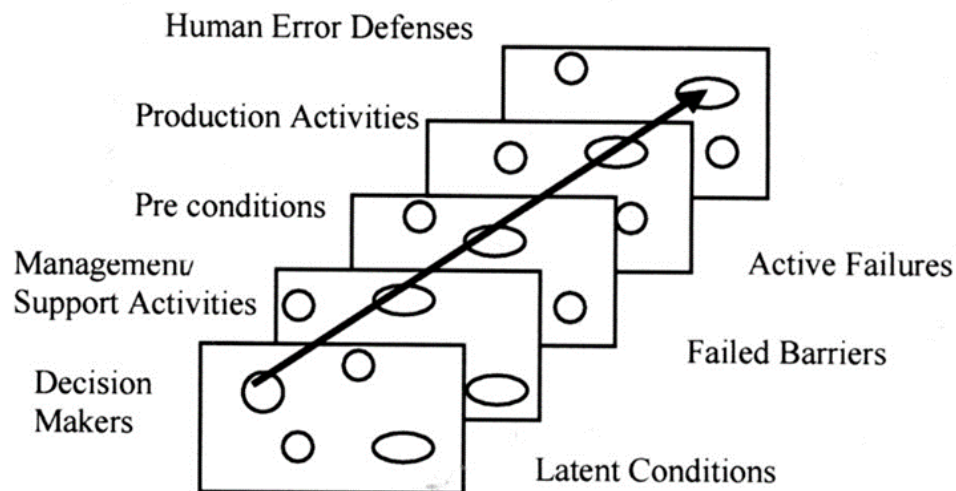


Figure 3. Reason “Swiss Cheese” model of human error and accident causation. From *Managing the Risks of Organizational Accidents* (p. 72), by J. Reason, 1997, Burlington, VT: Ashgate.

duty pilot onboard the flight joined the flight crew and between the three individuals, they were able to use the power control of the remaining two engines to land the plane in what the accident investigation concluded should have been a non-survivable situation. In-flight communications between the crew allowed all three members to control the aircraft whereby 185 of the 296 occupants survived. This accident, though a rare example of mechanical failure as a source, was controlled by the crew to allow for survivability (McKinney, 2005). CRM was an important reason for this. While CRM was evolving,

due to the publication of *To Err Is Human* (Kohn et al., 2000), there were changes occurring at the Federal level which would directly impact patient safety.

Shortly after its formation in 1999, the Agency for Healthcare Research & Quality (AHRQ) began researching medical team-training programs in response to the IOM *To Err Is Human* (Kohn et al., 2000) study. Medical errors were found to be similarly related to those found in aviation (Helmreich, 2000). A large percentage of these errors were due to human factors related to communications, decision making, interpersonal conflict and team work (Flin et al., 2002). The AHRQ was formed as the federal authority to coordinate all federal quality improvement efforts in health services research. As part of this, they were tasked with reducing the morbidity and mortality of the current healthcare system (Agency for Healthcare Research and Quality, 2012). In 2006, AHRQ released the qualitative study *DOD Medical Team Training Programs: An Independent Case Study Analysis* (Baker et al., 2006), which analyzed three of the most popular medical team-training programs that had been developed. They concluded that there was a need for additional safety and team training within the medical industry and that all three of these programs had potential to improve outcomes. However, in the 2006 study, authors also noted that none of them had quantitative data which could prove their effectiveness. They also stated that whatever team-training methodology was adopted, it should be universal and nationwide to be effective for collecting data and improving the system. Regarding CRM, they noted: “It is important to note that CRM is not a universal remedy. CRM by itself will not eliminate all the systematic contributors to medical error. Rather CRM is one component of a comprehensive approach to improving patient safety” (Baker

et al., 2006, p. 47). The knowledge gained in this pivotal 2006 study would lead to the development of the TeamSTEPPS program.

Given the success of CRM in the aviation industry and recommendations from the IOM report, concerns about CRM in its purest form from the *DOD Medical Team Training Programs* study, and knowledge gained from further research, the AHRQ developed a blended program called TeamSTEPPS which was released as a national standard for medicine in 2006 (King et al., 2008). Since that time, it has been tested and refined by hundreds of organizations. TeamSTEPPS has web-based materials and is openly available to all healthcare organizations for implementation in their organization at no charge.

TeamSTEPPS is based on 25 years of research related to teamwork, team training, and culture change. The basic curriculum of this program is subdivided into several themes: Team leadership, Mutual performance monitoring, Backup behavior, Adaptability, Team/collective orientation, Shared mental models, Mutual trust, and the use of Closed-loop communication. Each of these themes is subdivided into additional strategies and concepts to obtain success while minimizing additional harm or injury to the patient (King et al., 2008).

In related studies, the use of TeamSteps has been shown to be beneficial. In the study by Robertson et al. (2010), the TeamSTEPPS curriculum was imbedded in both a nursing and medical school curriculum for 213 students. All showed a statistically significant increase in recognition and use of teamwork skills compared to those without the training (Robertson et al., 2010). In a Surgical and Pediatric Intensive Care unit, TeamSteps was implemented resulting in improved staff perceptions of teamwork,

decreased nosocomial infections, decreased ECMO saturation times, and faster rapid surgical response teams (Mayer et al., 2011). Within the operating room, one institution found that implementation of the TeamSTEPPS program over 9 months resulted in statistically significant improvement in communications, proper antibiotic administration, venous thromboembolism administration, beta blocker administration and patient satisfaction (Forse, Bramble, & McQuillan, 2011). An Australian mental health study where TeamSTEPPS was implemented concluded, “TeamSTEPPS implementation had a substantial impact on patient safety culture, teamwork and communication. . . . It encouraged a culture of learning from patient safety incidents and making continuous improvements” (Stead et al., 2009, p. 128). There are a number of similar studies (Baker, Amodeo, Krokos, Slonim, & Herrera, 2010; Capella et al., 2010; Deering et al., 2009) that can be found that indicate TeamSTEPPS to be an effective team-training program. Given its successful implementation within nursing and medical school curriculums, could it also be effective in the education of paramedics in teamwork practice?

It should be noted that CRM has also been adapted by authors for direct implementation in fire, EMS, and related services (LeSage et al., 2011). Also, some medical institutions choose to implement CRM directly without the use of the TeamSTEPPS materials or program. These programs still utilize the same concepts since both are adapted from the root CRM principles (Flin et al., 2008). These programs have very similar themes to those presented within the TeamSTEPPS program, which makes sense since both utilize similar CRM concepts. For the purposes of my study, I focused on the concepts from the TeamSTEPPS program.



One very important theme in TeamSTEPPS and other similar programs is communications. In a study of 26 residents at a 600-bed teaching hospital, communication was one of the two commonly reported contributing factors to 70 medical errors experienced in the treatment of patients (Sutcliffe, Lewton, & Rosenthal, 2004). Associated issues to communications included hierarchical upward influence, conflicting roles and role ambiguity, and interpersonal power and conflict. All of these were impacted by poor communications; the results were greater patient harm.

Another theme in TeamSTEPPS is that of leadership. As an important supportive subcomponent to this theme is situational awareness or the overall awareness of what is happening within a particular event. It is impossible for a practitioner to properly treat a patient if he or she is unaware of the exact ailment confronting them. Inattention to subtle clues can be missed due to distracted attention. Often environmental conditions, other preexisting conditions, and previous experiences can serve to mask the clarity of determining the exact ailment or situation confronting a team leader. In a later section, I will discuss change and inattention blindness, which are directly related to leadership. It is clear from the research that hierarchical leadership structure can be detrimental to good team performance (Gibson & Singh, 2003; Nance, 2008; Rosenstein & O'Daniel, 2005). Because of this, alternatives to this structure must be taught. These alternatives are contained within many of the team-based training programs including TeamSTEPPS (Flin et al., 2002; King et al., 2008).

All of the research I reviewed indicates that TeamSTEPPS/CRM can be successfully integrated into both professional practice and initial training curriculums. The team-training components within TeamSTEPPS/CRM can be used to decrease

medical errors, and improve communication, leadership, teamwork skills, situational awareness, and medical safety (Flin et al., 2008; Flin et al., 2002; Robertson et al., 2010). This work has particular significance to my work as I am implementing TeamSTEPPS elements into the training of paramedics in simulation-based training.

### Simulation-Based Team Training

Much has been written regarding the use of high-fidelity simulation to teach important aspects of team training (Baker et al., 2010; Capella et al., 2010; Crofts, Attilakos, Read, Sibanda, & Draycott, 2005; Crofts et al., 2006; Crofts, Bartlett, et al., 2008; Crofts, Ellis, et al., 2007; Crofts, Fox, et al., 2008; Draycott et al., 2008; Ellis et al., 2008; Kohn et al., 2000; Robertson et al., 2010; Robertson et al., 2009; Rodgers et al., 2009; Siassakos, Crofts, Winter, Weiner, & Draycott, 2009; Small et al., 1999; Ten Eyck, Tews, Ballester, & Hamilton, 2010). Team training allows health practitioners to analyze their diagnostic decision-making skills, practice team communications, obtain feedback and remediation regarding their performance, and identify systemic problems within healthcare systems (Rosen et al., 2008). Rosen conducted a best-practices model based on other simulation studies which had been done. These best practices include:

1. Team performance measurement needs to be grounded in theory so that elements of measure are well defined and capable of identifying best practice. It must be specific to the area of focus (emergency medicine, anesthesia, pediatrics, etc.).
2. The design of simulations must have measures which meet specific learning outcomes. These outcomes must be based on the minimum standard of performance.

3. Team performance should be directly tied to the competencies which are being tested or learned. These competencies should be part of the expected knowledge, skills, and attitudes (KSA) expected of the team.

4. Good simulation team training explores and measures multiple levels of team performance. Communications, culture, skills, situational awareness, and other teamwork functions should be part of the exploration within a simulation.

5. Specific measures determined within a scenario should be directly linked to events which occurred during that scenario. The complexity of these events should mimic those found in the real world so as to force an accurate realistic measurable team performance within the simulation environment.

6. To avoid bias or error, observable behaviors should be the determiner of evaluative measures. The focus should be on what and why something was done, not on attempting to find blame. Performance should be based on factual evidence in recordings or actions rather than beliefs about why something was done.

7. Use triangulation to incorporate different measures from different sources to understand complex phenomenon observed. Often a strategy to review multiple actions is to use multiple raters and compare their observations regarding the actions observed. This provides a secondary source of data to that observed by the facilitator or participants within a simulation and can be key to understanding a phenomenon or problem that is occurring.

8. Capture performance using audio and video to allow team members to process both their individual and team performance actions during a critical event. Use this to identify good and bad actions to improve future performance.

9. Find the causes of effective and ineffective performance and identify these to the learners. This reference bank of knowledge, skills, and attitudes can create a library of reference for future training.

10. Observations need a structural protocol for making their measures. Likewise, all observers must be trained in this structural protocol so that their measures and observations are reliable and comparable.

11. Use facilitated post-simulation training and debriefs. A facilitator should be used to help the team identify the practices and actions which were observed in the simulation. The focus should be on showing best practices and decreasing sources for poor team performance.

The use of high-fidelity simulation in healthcare team training is a relatively new field of investigation. In her editorial discussion called “Team Performance Assessment in Healthcare: Facing the Challenge” (2008), Tanja Manser states, “So far, there is no common ground on how to measure team performance in healthcare, and theoretical as well as methodological challenges remain” (Manser, 2008, p. 2). Hanna and Fins’s (2006) editorial warns of using high-fidelity simulation alone to train healthcare practitioners. Within their commentary, they cite studies which indicate that while learning can occur in simulation, dynamics experienced in real life such as fundamentally connecting with patients may not be completely taught using simulation. They recommend using additional pedagogic approaches from liberal arts and live encounters to provide this learning (Hanna & Fins, 2006). They state,

If we want medical students to be able to be good doctors rather than merely to act like good doctors, then we also need to teach them to actually create authentic relationships with their patients, from inside themselves (from their hearts, so to speak). (p. 267)

Clearly there is still a great deal of research to do within the field of high-fidelity healthcare simulation regarding expanding the knowledge base.

### Situational/Perceptual Awareness

One of the observed behaviors often associated with errors is that of poor situational awareness (Borrell-Carrió & Epstein, 2004; Flin et al., 2008). Christopher Chabris and Daniel Simons (2010) have performed extensive research in this area and published some of their findings in *The Invisible Gorilla*. Their work has direct application to what I believe may be happening to our students. In the previous section, I discussed the 1977 Tenerife disaster where a plane attempted to take off blocked by another aircraft. This is known as a runway incursion and between 2004 and 2007 there were 1,353 in the United States alone (Chabris & Simons, 2010, p. 20). Where accidents have resulted, often the pilots will indicate they did not see the other plane during their approach or take-off. Richard Haines of NASA performed a study where he was testing Heads-Up displays for pilots to improve their ability to see these potential incursions without the need for looking at their instruments. In simulated landings, he placed a runway incursion before the plane that was landing. Two of the pilots never saw the planes they struck in simulation (Chabris & Simons, 2010; Fischer, Haines, & Price, 1980). As part of the debriefing, after both pilots viewed the tape of their collision, they stated, “If I didn’t see it [the tape], I wouldn’t believe it. I honestly didn’t see anything on that runway” (Fischer et al., 1980, p. 15). Chabris and Simons (2010) stated that this was an example of inattention blindness. While the HUD improved the ability to see, the fundamental way we perceive things is still the same. You might be thinking that this is a good airline situation, but what does it have to do with medicine?

In a case report on a near death due to medical error, a failure to identify a forgotten femoral guide wire resulted in life-threatening complications to the patient. The patient, a 43-year-old female, was having profuse vaginal bleeding and fainting as a result. A decision was made by the ER physician to insert a femoral vein-based infusion in the patient. For unknown reasons, the guide-wire used to insert the catheter was left in the vein. Despite numerous radiographic pictures that were taken which clearly identified the presence of the guide wire, the omission was not recognized. The patient began developing signs of an infection and pulmonary emboli, where a clot formed as the guide wire breaks free and travels to the lungs where it obstructs blood flow. This condition, if untreated, can be fatal. On the fifth day following the catheter guide wire placement, it was removed and the patient eventually recovered. The cause of this guide wire being missed was “inattention blindness” on the part of all who viewed the radiographic pictures. In their effort to find other causes, this simple practitioner-induced cause was missed. The active fault error was the failure to remove the guide wire, following insertion of the cannula. However, there were also latent faults by subsequent systems which failed to detect the guide wire once the procedure was finished (Chabris & Simons, 2010; Lum, Fairbanks, Pennington, & Zwemer, 2005). Clearly, the research on inattention blindness has direct application to medicine.

Chabris and Simons (2010) define inattention blindness as “when we fail to notice the appearance of something we weren’t expecting to see. The thing we miss, such as a gorilla, is fully visible, right in front of us the entire time” (p. 55). In both of the discussed situations, the threats, which were a guide wire on an x-ray and an airplane on the runway, were clearly visible but unrecognized due to inattention blindness.

Authors Simons and Chabris (1999) are probably best known for their study that demonstrates inattention blindness in their 1999 article “Gorillas in Our Midst: Sustained Inattention Blindness for Dynamic Events.” In their study, a videotape is played for subjects that shows two teams of three players bouncing a basketball back and forth between them. Subjects are asked to count the number of passes that are made by the white-clothed team. At 44 seconds of the 75-second video, a person in a gorilla suit slowly walks between the players, strikes its chest several times, and then walks off the camera. The gorilla is on tape for about 5 seconds of the total duration. At the end of the video the subjects are asked how many passes they counted. They are also asked whether or not they saw the gorilla? Forty-six percent of the subjects missed seeing the gorilla, demonstrating inattention blindness. Additional modifications were made to this experiment and tested as well. All showed inattention blindness (Simons & Chabris, 1999). The process of inattention blindness has been documented in numerous studies and publications regarding change blindness (Most et al., 2001; Simons, 2000; Simons & Chabris, 2010; Simons & Levin, 1997).

Chabris and Simons (2010) also identified a related but different condition called *change blindness*. In their book *The Invisible Gorilla*, they define change blindness as “when we fail to compare what’s there now with what was there before” (Chabris & Simons, 2010, p. 55). This condition explains how, during a movie, a viewer might not notice an object disappear and reappear between changes in camera views of a scene. This concept was tested in a number of studies. In one study, an experimenter asks the subject for campus directions on a map. During the discussion a door, carried by two other students, is briefly passed between the experimenter and the subject separating

them. During this passage, a second experimenter replaces the first and that second experimenter continues getting the directions. Only 7 of the 15 subjects realized that the experimenter had changed in the study. Most continued with their directions unimpeded (Simons & Levin, 1998).

Interestingly enough, most individuals do not believe they are very susceptible to change blindness. In fact, most individuals believe that they should be able to prevent their own susceptibility to change blindness. In another experiment, Daniel Levin explained to an audience that a movie clip experiment he had designed had plates that changed from white to red. Seventy percent confidently explained that they could easily identify that. Yet the same group was shown a film in which a scarf disappears from an actress. No one noticed. Levin describes this as change blindness or the disbelief that you can miss an obvious change. He considers it more dangerous since it indicates a lack of awareness of change blindness (Chabris & Simons, 2010). Given the overwhelming evidence that anyone is capable of inattention blindness and change blindness, is there any way to defend against it?

In the book *The Invisible Gorilla*, Chabris and Simons (2010) recommend a number of possible defenses against inattention blindness and change blindness. First, one should understand that change blindness is a tool that the mind uses to prevent cognitive resources, from focusing on unimportant tasks. It is unlikely that a plate will turn from red to white in the real world in a split second. Having cognitive resources assigned to monitor for this is not the best use of resources so for the observer to miss this should be expected. Second, using technology to help spot the changes can be helpful. In many industries, technology is used to help spot the changes and is often more efficient



than humans. A third defense against inattention blindness and change blindness was demonstrated by Simons and Levin (1998). They found that when tested as groups of three, it was less likely for all three to miss a change. Within TeamSTEPPS, situational awareness is for the entire group, not just the leader. Also, the use of “red flags” to alert the leader by any team member is an expected behavior. All of the above recommendations may be used with students participating in simulations to help avoid change blindness.

### Emotional Intelligence

As a part of leadership and in the management of a healthcare team, paramedics must interact with patients and other team members. This interaction can take a number of communication forms including non-verbal, verbal, written, and by electronic means. Treating patients and performing communications involves all senses and emotions. Human interaction is influenced by emotions, awareness of these emotions, and emotional intelligence, and can aid these communications and ultimately the leadership and efficient operations of a team. In his 1998 book, *Working With Emotional Intelligence*, Daniel Goleman defines Emotional Intelligence as “the capacity for recognizing our own feelings and those of others, for motivating ourselves, and for managing emotions well in ourselves and in our relationships” (p. 317).

Goleman published a figure showing his Competency Framework which demonstrates the impact of emotional intelligence within our lives, shown in Figure 4. Most elements of the emotional intelligence model fit within the four domains of self-awareness, self-management, relationship awareness, and social awareness. This framework has direct application to paramedics practicing in the field. Relationship

management includes the ability to show leadership, to influence and manage conflicts, and to create an environment of teamwork and collaboration. However, to do this, one needs emotional self-control which is found within the self-management domain.

Likewise, paramedics need to have emotional self-awareness on what they are projecting to others (Goleman, 2011). By doing this they demonstrate the skills necessary for team leadership, one of the many paramedic competencies that must be achieved (NHTSA, 1998; U.S. Department of Transportation, 2009). Mayer, Salovey, and Caruso (2004) studied emotional intelligence and also published an analysis of other studies regarding the benefits of Emotional Intelligence. They found that those with high EI had better academic performance, improved abilities to communicate motivating messages, and better measures of relatedness or teamwork (Mayer et al., 2004). The ability of leaders to read other emotional states and to understand how their actions impact on them can directly transfer to improved team performance (Goleman, Boyatzis, & McKee, 2002).

Shankman and Allen (2008) stated,

Emotionally intelligent leadership involves knowing how to build a team and be a role model of collaboration. Effective leadership results in an environment in which working together is expected. Emotionally intelligent leaders know how to work with others to build a sense of group identity. When teamwork happens, people tap into their own potential and look for ways to contribute to the group. (p. 114)

Improved team performance is a major goal of programs such as TeamSTEPPS and recommendations by the *To Err Is Human* study. Emotionally intelligent leadership may be one method to achieve this goal.

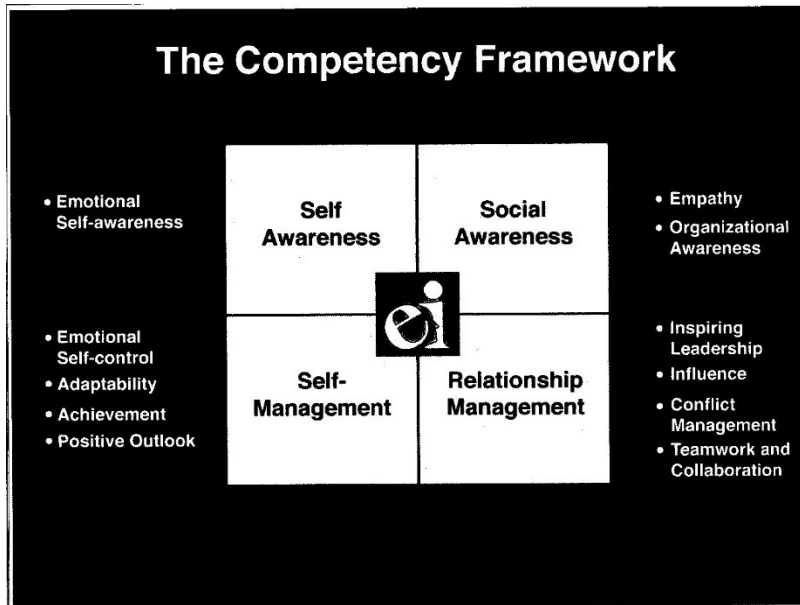


Figure 4. The emotional intelligence competency framework. From *Leadership: The Power of Emotional Intelligence Selected Writings* (p. 14), by D. Goleman, 2011, Northampton, MA: More Than Sound.

From my personal experience working as a paramedic and Medical First Responder, I noticed that other paramedics would often ignore First Responder teams as they entered to gain access to a patient. They would then often ask the exact same questions of the patient which had been previously asked by the First Response team. In acting this way, they essentially stated to the other team leader that there was little they could share that was of value to them or they could trust. They also created a condition whereby they had less respect from that team on future scenes. I had even seen First Response teams immediately leave the scene when the paramedics arrived. In retrospect, I believe I was seeing the impact of a lack of emotional intelligence on the part of those paramedics and the repercussions it brought. Goleman (1995) states, “Leadership is not domination, but the art of persuading people to work toward a common goal” (p. 149). Within my study, one of the teaching points to students is to maintain awareness that their

interactions in leadership roles will have consequences in their relationships. This is an important leadership trait. Can simulations be used to help teach this concept as part of the leadership role?

In the previous section, I presented the past and current work of medical teams in better teamwork skills and leadership development. I also gave a substantial historical record on how and why the decisions were made that have led the development of the current practices that exist. This research contains the content that was delivered to students within the study simulations. In this last section, I will discuss the process of high-fidelity healthcare simulation and related feedback methodology for learning, as this will be a major part of the methodology of this study.

### **High-Fidelity Healthcare Simulation**

This section deals with the process of high-fidelity healthcare simulation. This method of education has rapidly evolved over the past several decades. It is very difficult to point at one event and state this was the point when simulation started. Some researchers would credit the birth of simulation as early as the Song Dynasty in China where life-sized models were used in the teaching of acupuncture techniques complete with a liquid on the end of a needle to symbolize the correct placement (Owen, 2012). Others suggest the birth of medical simulation-based training with the development of Norwegian toy manufacturer Asmund Laerdal's Resusci-Anne in 1960 to teach cardiopulmonary resuscitation (Tjomsland, 1989). Many would point to the first development of the Sim One manikin in 1960 which duplicated many human characteristics including an anatomically shaped chest that moved with breathing, eyes that blinked and could dilate the pupils, a moveable jaw with an anatomically correct

inner airway, and the ability to produce limited human sounds (Denson & Abrahamson, 1969). However by 1980, the Comprehensive Anesthesia Simulation Environment (CASE) was the first manikin which included enhanced computer programming to allow the operator to run scenarios in the simulated education and training of anesthesiologists. Few would dispute that the evolution of simulation in medical education was now underway. Shortly following this, Laerdal Medical Corporation, Gaumard Scientific, and CAE, Inc. (formerly METI Corporation) would all separately develop a line of human simulators which continue to improve to this day (Cooper & Taqueti, 2004). These simulators represent humans of different ages, sex, and medical conditions.

Since the publication of *To Err Is Human* (Kohn et al., 2000), there has been an exponential growth in the medical simulation education and the technology used. This explosion in new simulation technologies includes the use of simulated patients, simulated environments, integration of patient monitoring technologies with simulation-based manikins, computer-based virtual reality simulation, task-trainer simulation, human haptic training, and more (Bradley, 2006). The use of simulation has been shown to be one of the most effective instructional modalities when compared to other learning methodologies (Cook et al., 2012). The industry is rapidly evolving.

The cumulative growth in simulation-based literature and knowledge has continued to exponentially rise. It is known that simulation provides the following learning advantages:

1. It can provide feedback during a learning experience.
2. It allows for repetitive safe practice.
3. It can be used to improve medical safety systems.

4. It can be integrated within a curriculum.
5. It has the ability to provide varied difficulty levels for learners.
6. It is highly adaptable to different learning strategies.
7. It provides a safe educationally supportive, controlled learning environment.
8. There is specific control over what is specifically experienced and learned.
9. It provides active learning that is based on individual needs.
10. Increasing degree of difficulty increases mastery of skills.
11. It can increase the number of patient encounters, including rare encounters.
12. It can replace at least 25% of the experiences gained in the clinical setting especially in specialty fields such as pediatrics.
13. It provides reproducible standard experiences to students.
14. Its concurrent validity ability on simulator learning transfers to real patients.
15. It can have defined outcomes and benchmarks.
16. It can be used to provide effective teamwork training in which communications, professionalism, and curriculum objectives can be taught using practical-based skills similar to a realistic setting (McLaughlin, Doezema, & Sklar, 2002).
17. It has high validity in realistic recreation of complex clinical situations (Bradley, 2006; Gaba, 2004; Issenberg, McGaghie, Petrusa, Gordon, & Scalese, 2005; Lambton, 2008; Sokolowski & Banks, 2011; Willett, Kirlew, Cardinal, & Karas, 2011).

Even though much is known about medical simulation, there are still many more questions that remain unanswered. These include the best methods to hone simulations to the need, how learners learn, what optimizes learning, what fidelity is ideal in

simulations, and more. In short, it is only the beginning of what we know in this new spectrum of simulation.

Much of the research and application of medical simulation has been in medicine, more specifically in the hospital setting. Less has been done in the pre-hospital setting, although the use of simulation manikins for the pre-hospital education and practice of resuscitation skills has been a staple since the mid-80s when several of the more advanced resuscitation manikins were released by Laerdal Medical Corporation (Tjomsland, 1989). Since that time, a number of individual task trainers, such as intravenous arms, chest decompression thorax manikins, and airway management trainers have been utilized in training and are even listed within minimum equipment lists for EMS training and education (State of Michigan, 2007).

Despite the limited number of pre-hospital simulation studies, there have been some which are significant and related to my work. Boyle et al. (2007) describe simulation centers in Australia which have trauma simulators, bedroom simulators, and related environmental simulators to allow for paramedics to practice their skills in a more realistic, yet simulated setting. Similarly, Michael Gordon (1999) writes on efforts at 12 medical centers which include the training of 3,000 paramedic/firefighters using simulation training. Much of the training was in ACLS and related coursework. There was a positive generalized acceptance of simulated training by pre-hospital personnel (Gordon, 1999). This was supported by a study which assessed paramedics' evaluation of simulators for fidelity and ability to duplicate actual pre-hospital patients. In this study, paramedics overwhelmingly (80%) indicated that simulation was an effective technology for learning within their profession (Wyatt, Archer, & Fallows, 2007).

One of the critical airway skills that paramedics must learn is that of endotracheal intubation. Traditionally, this skill is learned in the classroom using a task trainer. Following this, paramedics practice on live patients within the operating room of a hospital under the supervision of an anesthesiologist or nurse anesthetist. Hall et al. (2005) quantitatively compared the direct use of high-fidelity healthcare simulation to train paramedic students against the traditional OR-based methodology. They found that students who were trained using the simulator were equally proficient as those who were trained using the traditional “live patient” operating room methodology (Hall et al., 2005). This is significant as it is one more indicator that simulation training can be as effective as using live patients.

Within the overall field of medicine, there have been numerous studies regarding the use of high-fidelity healthcare simulation. Rather than describe all the aspects of medical simulation education, I will focus on those that have significance to my study. These include the fidelity of simulation, learning methodology of a simulation, and the use of debriefing with emphasis on feedback.

### Defining Fidelity

In the *Manual of Simulation in Healthcare*, Ray Page defines fidelity as “the degree to which the real world is reproduced or simulated” (Riley, 2008, p. 44). This definition originates from lessons learned within the aviation industry. In the National Academy of Sciences *To Err Is Human* publication, the aviation industry was cited as one of the industries which medicine can emulate in regard to simulation technology (Kohn et al., 2000). For this reason, many of the definitions and practices from the aviation industry were adopted for implementation within medicine.



The degree of fidelity is measured using two models. The first is through a direct method utilizing a mathematical measure called the objective method. This calculates the number of identical elements between a simulation and reality. A higher correlation of identical elements directly equates to a higher level of fidelity. The second is a more indirect method called the Fidelity Evaluation Frameworks method. This method creates a performance matrix for series of tasks that a trainee would accomplish whether in a simulated or real environment. The performance matrices for the tasks are compared against each other looking for measures of training transfer between the two environments. The greater the transfer, the greater the level of fidelity (Vincenzi et al., 2009). The advantages of the objective method are direct measures that can be compared. The advantage to the matrix method is that it is more flexible in adapting to different conditions and less defined concepts or observed behaviors.

Within the aviation industry, it has been suggested that simulation fidelity is directly linked to the level of transfer in training. Low fidelity simulation is adequate for novice tasks or skills within training; however, as more complex training and tasks are given, the fidelity has a direct relationship to the level of transfer (Vincenzi et al., 2009). However, it is also known that the higher the level of fidelity, the greater the cost of the simulator. Finding the beneficial point that maximizes the fidelity while minimizes the cost, yet maintains a high level of transfer in training has been significantly studied. There is great debate on how much fidelity is required to adequately accomplish a training task.

Like aviation simulation, medical simulation has been researching this same question regarding how much fidelity is required to optimize the level of simulation.

Further research suggests that the aviation lessons are accurate regarding fidelity.

Depending on what the specific learning objectives are, the fidelity of a simulation which is required will vary (Beaubien & Baker, 2004). For example, in the study of human factors and team performance, there are many studies which would suggest that higher fidelity results in higher learning (Crofts et al., 2006; Gaba, 2004; Hunziker et al., 2010).

Within medical simulation, fidelity plays a major role in determining the type and level of simulation required. Like their aviation counterparts, initial skills are often taught using lower fidelity task trainers. One example would be the use of a simplified IV arm for the initial learning of venipuncture and securing of an intravenous solution. As the task of venipuncture is placed within the more advanced sequence of treating a patient, additional factors such as the environmental conditions, patient's medical urgency for this procedure, and choice of the ideal timing for this intervention will all necessitate an additional level of fidelity. Now, rather than a simple task trainer, the IV may be started on a medium- or high-fidelity manikin capable of human speech, mimicking of human vital signs, and more. To investigate the leadership and human factors of team performance, an additional level of fidelity may even require the use of a live actor or actress to substitute for the patient. Thus, the fidelity of the simulation has a direct impact on the quality of learning. The exact level of fidelity chosen for the specific learning objectives may not be the highest available, yet it may be highly effective at performing the task (Riley, 2008).

While I've spent the last section discussing the fidelity of simulation using patient simulators as examples, environmental fidelity is also measured in simulation. The creation of simulation clinical rooms which mimic a hospital room, complete with

oxygen and suction delivery apparatus, hospital bed, cabinetry, and sinks are all examples of a higher fidelity environmental simulator. Often these facilities have permanently installed cameras which are linked to the simulation recording equipment, if used. Likewise, using a traditional classroom as a patient room would be considered environmental low-fidelity simulation. A high-fidelity patient simulator in a low-fidelity environment may not provide sufficient fidelity to produce the best results in a simulation, depending on the objectives (Sokolowski & Banks, 2011).

### Learning Methodology

Within a high-fidelity medical simulation, there are a number of common steps which are taken as part of the simulation-based learning process. These steps are shown in Figure 5. Within the design phase of a simulation, the facilitator must identify the objectives which will be taught within the simulation, identify how they will measure the student performance, determine the needs within the simulation regarding technology and simulators, and then write the script for the simulation. An example script is shown in Appendix B. Depending on the simulator used and requirements of the simulation, programs for the manikin(s) need to be written by the user and stored for use within the simulation. Once this is done, the simulation scenarios are ready for the learners (Kyle & Murray, 2008).

The learners usually attend a pre-simulation briefing in which expectations and information on what they can and can't do are shared. Following this, the learners engage in the actual simulation in which the learners experience realistic conditions and their actions change conditions within the simulation. There is a wide gamut of variation here

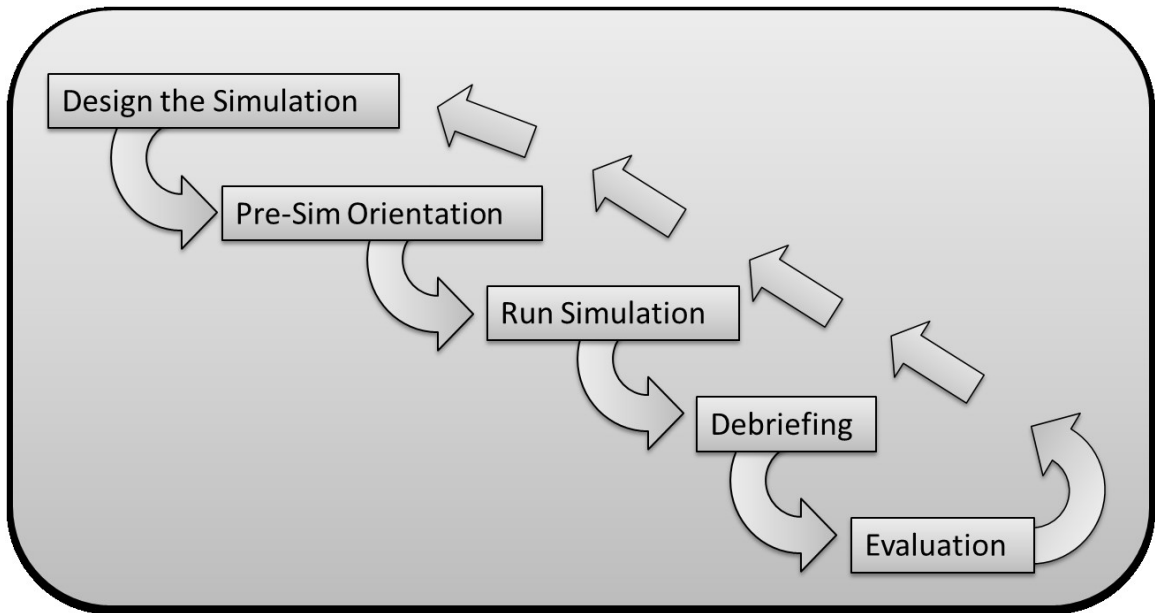


Figure 5. Common steps in high-fidelity simulation. Compiled from *Clinical Simulation: Operations, Engineering, and Management*, by R. R. Kyle and W. B. Murray, 2008, Burlington, MA: Academic Press; *Manual of Simulation in Healthcare*, by R. Riley, 2008, Oxford, NY: Oxford University Press.

and the simulation operator needs to determine the parameters which will be experienced prior to simulation. Decisions on how far to take the simulation—including possible death of the patient—hold significant consequences for the learner. Once the simulation has ended, the learners and facilitator(s) enter into the debriefing stage. During this time, discussion of the actions and learning occur. This debriefing can occur in a conference room, classroom, or at the simulated patient’s side, depending on the time and resource needs. Following the debriefing, an evaluation of both the simulation and design are performed to improve its use in the future (Kyle & Murray, 2008; Riley, 2008).

Many researchers and authors in simulation have paralleled the Kolb Learning Cycle with that of learning within high-fidelity healthcare simulation (Kyle & Murray, 2008; Riley, 2008). David Kolb (1983) states, “Learning is the process whereby

knowledge is created through the transformation of experience” (p. 38). He developed a model shown in Figure 6 which demonstrates an example of this learning transformation.

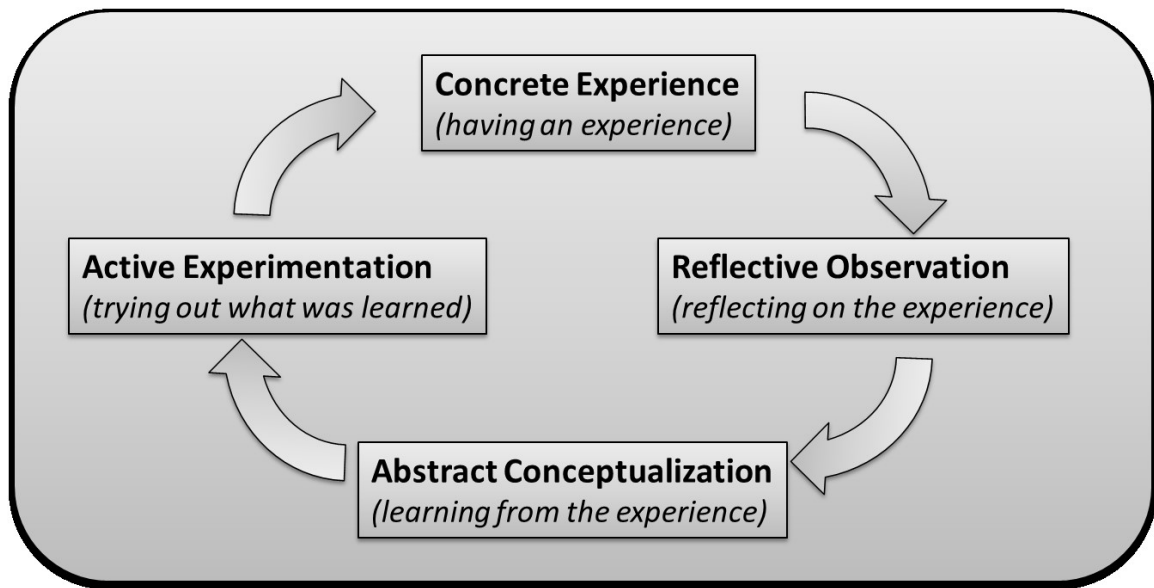


Figure 6. Kolb experiential learning theory. Developed from *Experiential Learning: Experience as the Source of Learning and Development*, by D. A. Kolb, 1983, Upper Saddle River, NJ: Prentice Hall.

Kolb had been exposed to John Dewey’s writings on experiential learning in his past. Both Dewey (1938) and Kolb (1983) argued that experiential learning was one of the best learning strategies to be employed. Dewey (1938) describes “objective conditions” as those conditions that educators control to provide an experiential learning experience.

It [objective conditions] includes what is done by the educator and the way in which it is done, not only words spoken but the tone of voice in which they are spoken. It includes equipment, books, apparatus, toys, games played. It includes the materials with which an individual interacts, and, most important of all, the total social set-up of the situations in which a person engaged. (Dewey, 1938, p. 45)

While written in 1938, the inclusion of simulation to this repertoire of experiential methods described by Dewey can be directly linked (Overstreet, 2009).

Dewey described the process of learner habit formation from the process of experiential learning in his 1938 book *Experience & Education*. "The basic characteristic of habit is that every experience enacted and undergone modifies the one who acts and undergoes, while this modification affects, whether we wish it or not, the quality of subsequent experiences" (Dewey, 1938, p. 35). If true, then the process of simulation—which uses experiential learning—may be more effective in forming new habits in the learners which will transcend the school experience and follow them into professional life.

Similar to Dewey's views, Kolb (1983) believed in experiential education. Kolb described his experiential learning theory as one which is formed from experiences which a learner is exposed to. Upon having a concrete experience, the learner then reflects on the experience, determining the cause and effect from that experience. After reflection, the learner attempts to create an abstract concept of what has occurred and why? This may be in the form of multiple fragments or ideas. They will then assimilate the experience into their own future behaviors trying out the newly learned behaviors or action, given another experience. Based on that experience, the learned behavior or actions are either further refined or accepted as the desired actions (Kolb, 1983).

There is a direct connection between medical simulation and Kolb's (1983) learning theory. A well-crafted medical simulation provides the stage for the student to have a concrete experience. This experience is based on the feelings and perceptions of the learner. Following this, during the debriefing stage of simulation and after the entire

simulation session, the learners reflect on their actions and the outcome that was experienced. They move from feeling or perception to abstract conceptualization or thinking. As a result of this reflection, learners may choose to change behaviors if confronted with similar circumstances. In this way, medical simulation utilizes Kolb's learning theory (Kyle & Murray, 2008; McFetrich, 2006; Riley, 2008).

It is interesting to note that Dewey, though writing nearly 50 years earlier, gave insight to the processes within Kolb's theory.

There should be brief intervals of time for quiet reflection. . . . But they are periods of genuine reflection only when they follow after times of more overt action and are used to organize what has been gained in periods of activity in which the hands and other parts of the body beside the brain are used.  
(Dewey, 1938, p. 63)

This description follows the reflection stage of Kolb's (1983) Learning Theory closely.

Another researcher, Schön (1983, 1987), has been closely linked to providing reflective feedback within the high-fidelity healthcare simulation process (Bradley & Postlethwaite, 2003). Schön's work fits well within the Kolb (1983) learning cycle as it expands on the concepts with application to professions. Schön (1987) investigated facilitated reflective feedback using the metaphor of coaching for the student. In this metaphor, the learner is coached by the facilitator to reflect on their actions. Schön describes a profession as more of an art form than technical rationality. "It is the entire process of reflection-in-action which is central to the 'art' by which practitioners sometimes deal with situations of uncertainty, instability, uniqueness, and value conflict" (Schön, 1983, p. 50). I have observed students in this exact state within simulations.

It should be noted that Schön worked on projects with Chris Argyris, who is probably best known for his work on single- and double-loop learning—a theory that has direct application to Schön's work (Argyris & Schon, 1974, 1978). Argyris (1976)

described single-loop learning as an experience in which an individual or organization can use predefined controls to control the output of the experience, similar to that of a thermostat. No changes in organizational or personal behavior are needed as processes are in place that can regulate the experience and adequately compensate for changes. However, in double-loop learning, the organization or individuals underlying norms, policies, and objectives will need to be modified for correction. This will involve re-evaluating the error and applying a process of unfreezing the current model, changing it, testing it, and then refreezing the model in a new fashion. There is resistance to the double-loop learning process since it requires much greater effort and costs on the part of the organization or learner. However, it can lead to a better model for the experience which caused the error (Argyris, 1976, 1978; Argyris & Schon, 1974, 1978). While Chris Argyris focused on all organizations and learning, Donald Schön continued to apply his work in medicine—specifically medical learning and reflective practice.

Schön contends that the best practitioners are capable of reflecting-in-practice, meaning they can constantly learn from their experiences, reflect on them (reflection-in-action), and then achieve a point of knowing-in-action. This knowing-in-action is the ability to know or recognize a similar situation from one's past and implement it within the present uncertain situation (Schön, 1983). Novice students may not have the experience to draw on to create knowing-in-action. As a result, simulation experiences help fill this void by creating the first steps towards learning or knowing (Bradley, 2006; Bradley & Postlethwaite, 2003; Gaba, 2004).

In their 2001 publication *Fostering Reflection and Providing Feedback*, Westberg and Jason cite several important reasons for promoting reflection in learners:



1. Inviting learners' reflections allows us to establish collaborative relationships with them. We engage as partners with them in learning.

2. By allowing reflections as novice learners, we promote reflection throughout their careers as professionals. This helps to create safe practice.

3. Better patient care is usually provided by reflective practitioners.

4. Non-reflective practitioners can be dangerous to patients and those around them by not being able to identify life-threatening or dangerous situations from similar experiences.

5. Students take greater ownership of insights and ideas that they discover.

6. Reflection allows students to build confidence by learning their strengths and deficiencies.

7. Reflection allows practitioners to be in better touch with their own feelings so that they can better provide compassionate, comprehensive care to patients.

8. Reflection allows learners to apply lessons learned from one experience to another, improving their professional abilities.

Westberg and Jason (2001) also found that reflection in the absence of feedback can be problematic, especially in novice learners. When an event occurs, different viewers will have different perceptions of what occurred. As a result, their interpretation may be different along with corresponding treatments. Because there is a lack of experience, novice learners may not be equipped to give themselves feedback in reflection. It is this point at which the instructor needs to properly provide that feedback so that it is conducive to learning. Ineffective or improper feedback can result in

improper learning or bad habits. Worse, in the absence of positive feedback, good behaviors may be dropped completely.

As part of their overall strategies to promote reflective learning in students, Westberg and Jason (2001) recommended having the students reflect on: (a) what they did well, (b) their overall impression, (c) what they were thinking when they made a decision, and (d) why they made the decision they did. As part of this discussion, it is the job of the instructor to guide the learner towards safe and effective practice as a practitioner. It is important that the instructor design experiences or simulations that elicit conditions which allow for reflective learning. Simulations and the use of video recordings for students to review with the instructor can be powerful tools to help stimulate learning.

Reflective learning requires active participation by learners in their learning process. In fact, active participation by adult learners is an important factor in increasing the effectiveness of their learning. “Adults learn best when they are actively engaged in the process, participate, play a role, and experience not only concrete events in a cognitive fashion, but also transactional events in an emotional fashion” (Fanning & Gaba, 2007, p. 115). Simulations can be very effective at stimulating the cognitive, psychomotor, and affective (emotional) domains of learning. However, to understand the experience, debriefing is required. In this next section, I will move from the conceptual theories of learning into their application within the debriefing process.

### Debriefing Facilitation

One of the most important aspects of simulation occurs during the debriefing period when participants have the opportunity to reflect on their actions (Riley, 2008).

Many experts have indicated that this is where much of the learning takes place (Dismukes, Gaba, & Howard, 2006; Dismukes, McDonnell, Kimberly, & Smith, 2000; Savoldelli et al., 2006). John Dewey argued that learning is something that students do for themselves and the teacher's role should be to provide conditions and activities that should stimulate learning (Dismukes, McDonnell, & Kimberly, et al., 2000). In simulation, clearly the learning is student centered. However, unguided learning—especially in the novice learner—can be detrimental if not meaningless (Savoldelli et al., 2006). The facilitator's role is crucial to the learning process in simulation.

While most forms of simulation have a formal debriefing session following the simulation, there are variations to this theme as well as many different styles. The actual act of debriefing is a specific feedback process itself (Fanning & Gaba, 2007). Some facilitators prefer to correct actions within a simulation as they occur during the simulation. In these situations, the debriefing is on-the-fly and a formal debrief time is omitted. Others utilize learning tools such as individual student video reviews of their performance with or without an instructor. While all of these forms may have validity (Beaubien & Baker, 2003), for the purposes of this study, I focused on the form of debriefing which originates from the CRM model and is most popular currently within healthcare simulation, that of facilitator- or instructor-mediated debriefing following a simulation.

Within debriefings, there are actually two different roles which are played by those conducting the debriefing. Facilitators are those individuals who foster and create reflective learning environments that cause the participant to reflect on his/her actions in reflective practice. However, at times, there is a knowledge deficit by students

participating in a simulation. When this occurs, the instructor role must be used. In the instructor role, core knowledge is presented to the students so that they can understand a particular situation. The roles of instructor or facilitator can be performed by two separate individuals or performed by one individual (Kyle & Murray, 2008; McDonnell et al., 1997).

A very important concept that has been present in multiple studies is that of creating a safe environment for the learner where they can express their feelings and thoughts without embarrassment or ridicule from others (Dismukes et al., 2006; Fanning & Gaba, 2007; Gaba et al., 2001; Riley, 2008). To create this environment, the facilitator must counsel the participants on expected behaviors. In the Clendinneng (2011) study, students were afraid to share due to anticipated reprisals from employers should their thoughts be known. As a result, they did not share, which potentially impeded their learning experience (Clendinneng, 2011). Unfortunately, the research on methodologies for creating a safe environment is limited (Riley, 2008).

The National Aeronautics and Safety Administration (NASA) published an excellent resource for facilitating debriefings titled *Facilitating LOS Debriefings: A Training Manual* (McDonnell et al., 1997). While designed primarily for airline CRM debriefings, it actually has significant application to medical debriefings as well. Some important principles which were presented include:

1. Keep debriefings centered on crew performance rather than individual performance. Individuals can analyze their own performance more deeply once they have more information to draw on.

2. Set expectations for crew participation both during the simulation and debriefing.

3. Adjust facilitation to the level needed to engage the crew to the maximum extent possible.

4. Draw out the quiet participants so that they too participate in the debriefing. When asking questions, use open-ended questions which force the student to answer the question regarding why they felt that way or performed a task the way they did. Close-ended questions do not allow for exploration.

5. Don't be afraid to use silence during a debriefing. After asking a very critical question, often the learner requires time to produce a response upon reflecting on the actions. Give that time. A good facilitator will look relaxed during this time, even smiling to put a crew at ease.

6. Ensure that all topics identified for review during the simulation are discussed. It is important to allow the students to analyze how the situations encountered were managed by their actions. What actions improved or thwarted the intended response? How did things turn out and why? What would they do differently given a similar situation in the future?

7. Reinforce positive aspects of student performance.

8. Have a flexible agenda, allowing students to drive the discussion on a point.

While performing the above recommendations within a debriefing, the following are steps to be avoided during the debriefing by the facilitators:

1. Avoid instructor lecturing resulting in the debriefing become an instructor-centered session. Debriefings should be learner centered. Avoid long monologues by the facilitator/instructor regarding improper performance or teaching.

2. Avoid giving facilitator-based analysis before the participants do their own analysis. Analysis by the facilitator is important, however, only after the students have had adequate time to reflect and discuss their actions.

3. Avoid leaving the impression that only the facilitator or instructor's impression is valid. The debrief should be learner centered and open to multiple interpretations.

4. Avoid interrogation of participants. Be positive when discussing problems.

5. Avoid short-changing high-performing crews by cutting their sessions short.

These strategies, as presented in the NASA document, are good starting points for facilitating any debriefing (McDonnell et al., 1997).

In addition to the above strategies, the use of video to remind crews of what events transpired during critical segments of a simulation can be invaluable. Videos encourage self-assessment and allow participants to see their performance. But it is important that video be used wisely. The LOS document gives some important points to using video within a debriefing session:

1. The facilitator should index important points they wish to use within a debriefing prior to debriefing.

2. Only video should only be shown that will be discussed in the debriefing.

Using video without discussion wastes time and opportunity for discussion about meaningful points.

3. Avoid showing a large number of segments or very long segments within a debriefing. In a 1-hour session between three to six segments are usually sufficient to identify key points and discussion.

4. Be familiar with how to correctly use the video playback equipment/software, and introduce any video segment presented so that all learners know the context for what is about to be seen.

5. Don't be afraid to pause for comments or discussion of important issues or clarification requested by the participants (McDonnell et al., 1997).

Following the publication of the *Facilitating LOS Debriefings* NASA document (McDonnell et al., 1997), a number of studies were conducted which applied these principles to CRM debriefings. Dismukes, McDonnell, and Jobe (2000) studied the techniques presented at five major airlines in 36 debriefing sessions. The methodology for debriefing was found to be effective, but inconsistency between facilitators was noted. Additional training specifically for facilitators was recommended.

Since the earlier CRM/airline-based publications on debriefing, a great number of studies have been performed adapting that methodology to high-fidelity healthcare simulation. In general, the above lessons discussed have been confirmed in multiple studies, though more research is needed (Issenberg et al., 2005). Of interest to my study is a study by Rudolph, Simon, Dufresne, and Raemer (2006), which calls its method "debriefing with good judgment." A major tenet of this method is moving from a judgment-based debriefing to a debriefing which uses good judgment. The goal of this method is to have the learners discover their own mistakes within the debriefing rather than having the facilitator or instructor point them out. The latter carries a series of

negative emotions which can cause problems for the learner and impede on the safe learning environment. It is important the learner not become defensive about the lessons learned, but rather accept them as part of the learning process when using this approach (Rudolph et al., 2006). This was an important concept that was brought into the debriefings within this study.

### **Summary**

In reviewing the research, I have presented several studies which are similar to the one that I conducted. I have also given a background to the EMS education requirements, learning of teamwork, and use of high-fidelity simulation. I have presented the accepted theories which impact and guide my study along with brief histories of how we have arrived where we are. In Chapter 3, I present the methodology of my study, based on the previous studies and learning that has taken place.



## CHAPTER 3

### RESEARCH METHODOLOGY

#### **Introduction**

This study used existing data from a 4-year period of time. When this project was first started, it was uncertain whether or not conditions would be successfully completed which allowed for success in simulation. For that reason, several phases were developed which allowed for incremental exploration. The first year was proof of concept for what could be developed. In this first year, the alpha phase, many of the tools for learning were developed. This included building and testing the simulators, designing the simulations, and preparing for the first students in these prototype simulations. This alpha phase refined many of the instruments that would be used to conduct this study. Prior to this point, simulations of this nature had not been attempted on this scale.

The beta phase lasted through the second year of the project. This was the first year in which what was thought would be the completed series of scenarios was first tested. It consisted of 11 modules as opposed to six in the alpha phase. The beta test also had a number of elements corrected from the alpha testing.

Years 2 and 4 were the actual years where refined student data could be collected to answer the underlying question of how paramedic students learn using simulation and audio-visual facilitated feedback. Years 3 and 4 yielded the most information as they

utilized additional tools to survey students on their learning. In addition, the quality and consistency of the debriefings and facilitation improved over time.

In the next section, I will review the methods chosen for performing this study. Following this, I will describe the ways the data were collected and then analyzed. By providing this information, the reader will gain a better understanding of the context and methods under which this study was performed.

### **Research Questions**

The overarching research question is, What and how do paramedic students learn in a high-fidelity healthcare simulation program that includes audio/video and instructor-facilitated feedback? To better answer this question, seven sub-questions were developed.

These are:

1. How do students describe high-fidelity healthcare simulation instruction?
2. How do high-fidelity healthcare simulations augment clinical experiences for paramedic students?
3. How does the facilitator/debriefer assist the paramedic in learning within a high-fidelity simulation environment?
4. How does the simulation environment contribute to student learning?
5. How does the facilitated audiovisual feedback in debriefing influence the student learning?
6. How does the simulation experience develop leadership skills?
7. What kind of learning is healthcare simulation uniquely designed to provide?

To answer these questions, it was determined that primarily qualitative research methodology was the most effective instrument to use.

## Methods

The methodology of this study is based on case study—more specifically, that of intrinsic case study. In this next section, I will explain why case study was selected, followed by the decision to use the more specific intrinsic case study format. It was these methods that allowed for the answering of the overarching question of how paramedic students learn from high-fidelity healthcare simulation with facilitated audio/video feedback.

Within this study's literature review, an important theme that continued to appear was that of culture and learning (Hanna & Fins, 2006; Rudolph et al., 2006; Westberg & Jason, 2001). The planned use of video recordings was intended to allow for a review of the data; however, it also served to immerse the researcher into the lives of the learners experiencing the simulation. Observations of speech, behavior, interactions, situational awareness, and more all yielded themselves toward a case study approach. In *Designing Qualitative Research*, authors Marshall and Rossman (2006) refer to the degree of close interaction between the researcher and participants and complexity of the study's design. "Case study, the most complex strategy, may entail multiple methods—interviews, observations, document analysis, even surveys" (p. 56). "A case study is an in-depth exploration of the bounded system (e.g., activity, event, process, or individuals) based on extensive data collection" (Creswell, 2012, p. 465). Within this study, the bounded system is represented by the process of high-fidelity healthcare simulation. Methods planned within this study include interviews, observations during the briefings, simulations and debriefings, analysis of participant-completed run reports, and both entrance and exit surveys.

Yin (2009) defines case study research as a linear and iterative process as shown in Figure 7. Often within a research project, researchers don't know what they don't know about the study. This was the case within this study—as discussed in Chapter 4: There were more questions as I progressed in the study. While it was known from the research that various elements and constructs had been successfully used in other specific applications, there was no information on their effect when combined in a paramedic training program, yet alone how to do it. For this reason, Yin's methodology played a crucial role. Within Yin's case study research text, he defines the elements of case study research as plan, design, prepare, collect, analyze and share; however, within these elements, as shown in Figure 7, there is an inter-relationship to each other.

The use of Yin's (2009) case study structure guided this study and is evident in the Chapter 4 context section. There, you can see the study progress through the various elements over the 4 years. As it progressed, additional questions were asked and answered, resulting in the completed study.

Throughout this study, based on the process of high-fidelity healthcare simulation, it was known that there would be a close relationship between myself and the subjects. Such a relationship is key to understanding the experiences of the learners and helped determine the best conceptual framework and study methodology utilized. Because of this close relationship, the specific case study format of intrinsic case study was chosen for use in this study.

Creswell (2007) states about intrinsic case study: “The focus is on the case itself (e.g. evaluating a program, or studying a student having difficulty” (p. 74). Regarding the intrinsic form of case study, Robert Stake (1995) states:

We are interested in it, not because by studying it we learn about other cases or about some general problem, but because we need to learn about that particular case. We have an intrinsic interest in the case, and we may call our work intrinsic case study. (p. 3)

Stake (1995) maintains that the focus within intrinsic case study should be the case itself and not necessarily be generalized towards other populations. Applied to this study, the case is understanding the learning which takes place when high-fidelity healthcare simulation is applied to paramedic students within their program.

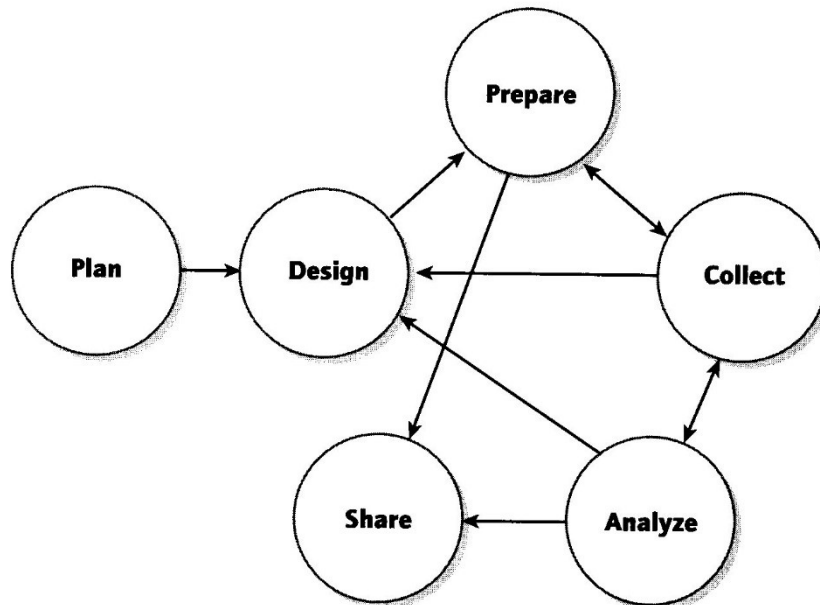


Figure 7. Case study research a linear iterative process. From *Case Study Research: Design and Methods* (p. 1), by R. K. Yin, 2009, Thousand Oaks, CA: Sage.

In describing this case study, a thorough job of describing the context under which the data were collected must be done. “The more the case study is an intrinsic case study, the more attention needs to be paid to the contexts” (Stake, 1995, p. 64).

Therefore, within this case study, details of some of the specific simulations must be

included to understand the exact context under which the students experience their learning.

Stake (1995), in his book *The Art of Case Study Research*, states on intrinsic research: “We are interested in it, not because by studying it we learn about other cases or about some general problem, but because we need to learn about that particular case.” Further, he states regarding intrinsic, “we have an intrinsic interest in the case and we may call our work intrinsic case study” (p. 3).

In summary, case study was the chosen method for this study because it provided a bounded system for data collection given the close interaction between myself and participants. The specific intrinsic methodology was selected (a) due to the imbedded nature of the researcher among the participants within this study; (b) with the need to focus on this specific learning process; and (c) given the importance of context in the performance of this research. This intrinsic case study methodology allows for exploration of the research questions.

### **Creating the Structure**

To investigate how learning takes place in a high-fidelity healthcare simulation, there must first be a body of knowledge to be learned and practiced. One of the first tasks was to formulate a structure for simulation so that this question could be answered and the research methodology could be applied. This was essentially the day-to-day operations which were used to conduct the study.

The model for simulation was based on the information presented in the *Manual of Simulation in Healthcare* (2008) by Riley. In this book, the structure for performing high-fidelity simulation was gathered. These included steps to developing the

simulations, conditions which create a positive environment for the learner, and current research on the art of high-fidelity simulation. The information in this manual was instrumental towards developing the simulations that were used. It was also supplemented by additional studies which have been presented in the literature review.

In addition, to help mitigate medical errors, the concepts presented in the TeamSTEPPS and Crew Resource Management (CRM) programs were infused into the paramedic simulation education. Not all of the concepts in TeamSTEPPS or CRM were used since some of them had greater application in the hospital rather than pre-hospital setting. Those that had direct application were used within scenarios to educate paramedics in safer practice.

In facilitating the debriefing, several models were used. First, *Facilitating LOS Debriefings* (McDonnell et al., 1997) was key in understanding the concepts of debriefing from the airline industry. The concepts presented in this document helped to form a framework for conducting the debriefings. In addition, studies on facilitating feedback and reflection in learners supplemented this debriefing process (Beaubien & Baker, 2003; Issenberg & Scalese, 2007; Westberg & Jason, 2001). Finally, numerous studies which have been presented in Chapter 2 were combed for application to the learning in this study within the field of debriefing. The combination of this information, along with observation and practice on the part of the facilitators, led to debriefing which fostered learning, which allowed for addressing the primary question of this study.

### **Developing the Setting for the Study**

From the research performed, creating high-fidelity healthcare simulation required the replication, as closely as possible, of the conditions which a paramedic

experiences when practicing their profession. In doing this, one of the first decisions was to create an optimal number of environmental simulators capable of duplicating the surroundings experienced by the paramedic. At minimum, these would include a scene to which they would respond, an ambulance in which they transport the patient, and an emergency room where they transfer care to another medical team. All of these simulators would need to be capable of capturing audiovisual information requiring the installation of cameras and microphones, which allowed for good viewing of the action while not interfering with the actions of the crew.

Besides building environmental simulators, there is a need for patients either in the form of simulators or standardized patient actors/actresses. To do this, a determination of the exact needs within simulations needed to be known. Once these needs were determined, research on manikins available and safe roles for standardized patients could be used to determine what resources to acquire. There are many different manufacturers and manikin types available in the marketplace. A decision on what to acquire needed to be determined.

Closely related to the manikins chosen, the exact scenarios to be designed needed to be determined. One of the requirements which novice paramedics must achieve in their education is the achievement of competencies. From previous research, it is known that some competencies are more difficult to achieve than others due to a lack of clinical experiences available (Dawson et al., 2003; Salzman et al., 2007). Written simulations were designed to address these deficient competencies. A format for scenario design based on CRM simulations was chosen and used to construct scenarios. A plan was developed to determine how many simulations could achieve the competency deficits and



became the completed plan used within the beta phase (year 2) of the project. For the alpha phase, simulations were selected that represented the spectrum of simulations planned.

In reviewing the needs of the simulations, it was clear a number of the procedures could not be done on live actors/actresses for safety or ethical reasons. In these situations, a manikin would need to be used. This turned out the majority of the time. The manikin chosen would need to be one which could easily move from environmental simulator to environmental simulator, yet remain operational. It needed to be battery powered and capable of wireless controls.

### **How Modules Were Conducted**

Each year was divided into a number of simulation sessions called modules. A module would typically contain two to three simulations which all the students would participate in. At the beginning of a module, the first thing students were exposed to was a PowerPoint briefing to prepare them for the day. In this briefing, they would first be given reminders on their roles in the simulation. These included the responsibilities for a team leader and team members including the level of medical procedures they were allowed to operate at within the simulation for their role. If the person were functioning as a Medical First Responder, they could perform only BLS skills and knowledge. If they were part of the Ambulance crew, they could operate at the paramedic level, although only the team leader was to be considered a fully licensed paramedic for the purposes of the simulation. Reminder actions, such as run reports, equipment restock forms, and other documents, were given in this briefing.

In the next segment of the briefing, specific “sim-isms,” a term coined to describe things the simulators could not mimic or show in a normal way, were shared with the group so that if they encountered them, it would not cause problems. Examples of simisms are the manikins which display cyanosis. In a real human, when cyanosis develops, it’s usually present throughout the body. On the manikins, it is varying color of blue light that shines through the face. The more blue, the more cyanotic or lack of oxygenation. The use of small Post-it notes were also commonly used on the manikin to state conditions or signs that could not be displayed by the manikin.

In the next part of the briefing, the students tossed dice to semi-randomly assign roles in the simulations. Roles included Paramedic Team Leader, Medical First Responder Team Leader, Ambulance EMT, and MFR crewmembers. While random high-dice throws determine the roles, if a student had not recently been in one of the roles, they were automatically placed in that role. The goal was an even disbursement of roles between students.

Just prior to the ending of the briefing were two important slides that always were shown. The first one was a statement, “What happens in the simulation lab must stay in the simulation lab.” The second was, “Remember, this is a ‘fun’ experience but also a safe place where you can make mistakes without penalty. How much you learn is determined by how much you put into it. Professionalism is not only required, but expected.” Both of these slides set the expectations for the learners in creating a safe learning environment where they could speak up and discuss anything without fear of reprisal. This was an important theme presented in the Chapter 2 research in multiple sources.

Occasionally additional information may be presented in a briefing to increase the realism or difficulty level. For example, after the first few simulations, multiple hospitals were made available to the students along with possible helicopter availability. This introduced a new dimension to decisions about transport priority and destination based on what facility was most likely to specialize in their problem.

The briefing would end and students would move their equipment and personnel outside of the simulation lab. They were called to the scene in a tiered response, where first the MFRs arrive, followed by the paramedics 4-8 minutes later, by two-way radio. Students were expected to use normal communication protocols, letting dispatch (simulation operators) know when they arrived on scene, needed additional resources, were enroute to the hospital, or arrived at the hospital.

During the simulation, they responded to the simulator based on the dispatch information received. They had the same resources available to them in the simulation as they would in real life. If they requested police assistance, it would be provided. In most scenarios, the students would need to move the ambulance for transport and then, after a period of time, arrive at the hospital where they would give a report to the ER crew. Sound effects for sirens and road sounds were used in the ambulance during transport. The simulation would end when the ER crew or a simulation operator announced the simulation was over. Crews would then clean, repack, and replenish their equipment so that they were prepared for the next call.

Once the crews were prepared for the next call, they would enter the debriefing room. All simulations were recorded in all simulators. During the simulation, the facilitator had tagged sections of the recordings for discussion during the debrief. These

were then discussed in the debriefing as part of the phases of debriefing. Once the debriefing was completed, crews would return to the staging area in preparation for the next simulation. This process continued until all simulations that could be done in the time period were performed.

### **Data Collection**

To understand how the paramedics learned, and based on previous studies recommending multiple angles (triangulation), data collected would need to be from several different sources. More explanation of the specific data collected and used is shown in Chapter 4 under the section Data Collected. In that chapter, data usage within the study shows what specific data were collected and how they were used to construct the report.

First, surveys were completed by students prior to starting the simulation component of their paramedic program. These surveys collected data about their previous beliefs and experience with high-fidelity healthcare simulation. Following the complete simulations series, follow-up video interviews were conducted asking about their specific experiences. The results of both of these surveys have been presented in the data section.

Second, every briefing, simulation, and debriefing for every module was video-recorded and stored. These electronic recordings allowed for more detailed analysis of the errors and learning which occurred during the simulation. Later, these were analyzed in more detail by electronic coding for general themes and errors observed.

Third, student documents including run reports from the simulations, tracking of competencies completed in simulation, and evaluations following each simulation were collected to review what students learned and observed. Also, a review of their

evaluations of the simulations and debriefings was used to evaluate their perception of their learning experiences with simulation on a weekly basis.

### **Analysis of the Data**

Following the completion of a module, the videos were reviewed. Actions performed were compared against the script for expected behaviors. Where inconsistencies between the expected behavior and actual behavior were found, the inconsistency was noted in my notes. These inconsistencies were later grouped into the following categories based on what was observed:

1. Leadership & Delegation
2. Situational Awareness
3. Sentinel Event Management
4. Communications
5. Skills Performance
6. Observed Errors (including trends)
7. Student Learning
8. Other (if not found in the above categories).

In addition, the type of error, when observed, was initially categorized using Reason's four categories of errors. Notes on the source(s) of the specific error(s) were made.

Following analysis of all the simulations, the categories were reexamined in each area. In some cases, categories/subcategories such as leadership were added as they were discovered from feedback and observations. A summary of what was observed was

created in the form of overall themes. This analysis was used to understand what mistakes and learning took place as a result of the simulations.

### **Data Collected**

This study collected a copious amount data over the 4 years it was conducted. These data took the form of electronic audio/video/data recordings, written reports from students, researcher documents, and collections of materials. These items, along with their description and years of collection, are summarized in Table 2. The documents listed are student or instructor generated and contribute greatly to both the qualitative and quantitative data collected.

The audio/video/data recordings were used to capture data for every briefing, simulation, and debriefing conducted in the study. Included in these data are four separate camera feeds, audio from the cameras, manikin control parameters (vital signs, activation of specific functions, etc.), patient monitors, and a running timeline with time encoded notes from the Researcher/Debriefing. These data allowed for the debriefing as well as tracking simulation events for later use in this report. Table 3 shows how the data sources were used in this study.

### **Quality of Research Design**

The quality of the research design has been measured using a variety of different methodologies. Yin (2009) states that four common tests for good case study research design should be construct validity, internal validity, external validity, and reliability. Validity is also known as trustworthiness by some researchers (Bloomberg & Volpe,

Table 2

*Summary of Collected Data*

Data Element	Description	Years
<u>Electronic Audio/ Video/Data Recordings</u>		
Briefings	Electronic recording of briefing conducted at the beginning of each simulation conducted	All
Simulations	Electronic recording with time-event instructor encoding of each simulation conducted	All
Debriefings	Electronic recording of debriefing for each simulation conducted	All
Exit Interviews	Exit interviews of students upon completion of last simulation module	Years 2, 3 and 4
<u>Student Reports</u>		
Student Competency Log Book	A logbook containing all clinical and simulation competency experiences for the entire school year	All
Clinical Folder	A logbook containing all clinical and simulation competency experiences for the entire school year	All
Student Run Forms from Simulation	Student-generated run reports for each simulation that they were a team leader	Years 2, 3 and 4
Student Evaluation Forms	Student-generated evaluations for each simulation module they participated in	All
Simulation Summary Form	Student-generated summary of experiences within simulation modules	All
Student Reflection Log	Student-generated reflection questions on modules they experienced	Year 4 only
<u>Surveys</u>		
Presimulation Student Survey	Student pre-simulation survey responses	Years 3 and 4
<u>Instructor/Researcher</u>		
Simulations & Related Documents	Instructor-generated simulation scenarios including curriculum objectives, type, description, required equipment, event sets, manikin programming, and protocols	All

Table 2–Continued.

Data Element	Description	Years
Simulation Planning	Simulation spreadsheets, planning documents, schedules, class schedules, and related documents	All
Simulation Evaluation Notes	Instructor-generated notes regarding observations of simulations and debriefings that were conducted	All
Feedback From Students	Notes, discussions, and other feedback received by the Instructor regarding simulation both during the simulations and after graduation	All
Anecdotal Notes	Instructor- and staff-generated anecdotes	All

2008; Ridenour & Newman, 2008). The next several sections deal with how my methodology met the standards.

#### Construct Validity

Establishing construct validity involves developing less subjective and more objective measures to collect the data within a case study (Yin, 2009). Some key strategies to achieve construct validity include using multiple sources for data—also known as triangulation, establishing a chain of evidence, and sharing draft reports with key participants. Table 3 shows the multiple data sources that were used in the data collection process. The use of the electronic recordings, students’ reports, surveys, and instructor documents all allowed for triangulation later in the data analysis. Triangulation was present at multiple levels within this study including: (a) between students and faculty; (b) between students’ comments; (c) between subjects discussed within this study; (d) within the methods used in this study; (e) this information was collected for each year on all modules conducted as part of this study; and (f) between multiple



years/cohorts. In reviewing Table 3, the reader will see that a chain of evidence is clearly established between the data chapters where the evidence was presented and the sources

Table 3

*Data Usage Within the Study*

Data Chapter	Section	Electronic AV Data Recordings				Student Reports						Surveys	Instructor/Researcher Documents				
		Briefings	Simulations	Debriefings	Exit Interviews	Competency Log Book	Clinical Folder	Simulation Run Forms	Evaluation Forms	Summary Forms	Reflection Logs	Presimulation Survey	Simulations & Related	Planning	Evaluation Notes	Feedback from Students	Acetodal Notes
4: Context	Data Collected	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Timeline												•	•			•
	Year 1: Alpha Year	•	•	•			•						•	•	•	•	•
	Year 2: Beta Year	•	•	•			•						•	•	•	•	•
	Year 3: A New Simulation Lab	•	•	•			•						•	•	•	•	•
Year 4: Deeper Questions	•	•	•			•						•	•	•	•	•	
5: Quantitative	Simulations Conducted	•	•	•								•	•	•			•
	Student Participant Demographics										•						
	Competencies Achieved	•	•	•		•	•					•	•				
6: Qualitative	Student View of Simulation				•				•	•	•						
	Student Perception of Simulation				•					•	•						
	Comparison to Traditional Clinicals				•		•			•				•	•	•	
	Student View of A/V use			•	•					•	•						
	Instructor-Facilitated Feedback		•	•	•				•	•	•			•	•	•	
	Learned Leadership		•	•	•			•	•	•	•			•	•	•	
	Student View of Control Room				•				•	•	•						
	Observed Errors	•	•	•								•		•			•
	Learning Technology											•	•				•
	What Students Say they Learned				•				•	•	•						
	What Students Say caused Learning				•				•	•	•						
	Domains of Learning				•		•	•	•	•	•						
What Students Say about Simulation				•													

*Note.* A/V = Audiovisual. At the top of this table are the data sources found in Table 2. The left columns show the data chapter and section in which the data were used. A “•” symbol indicates the data were used in the construction of that section.

where it was collected. These sources were maintained by the researchers and were specifically labeled and identified for easy forward and reverse identification through the chain of custody whether it be within the data chapter of collection point. Upon completion of the draft version of this report, these findings were shared with instructors and students involved in the study for comment. All of these tactics supported the construct validity of this report.

### Internal Validity

In case study methodology, internal validity is strongest to the degree that the observed phenomena matches reality (Yin, 2009). Much of the internal validity of a study can be improved by matching observed patterns in the data, addressing rival explanations, using logical methods to analyze the data, and build explanations based on observable provable sub-components. Models are often constructed that aid in explaining what is observed. In the construction of these models, alternate explanations must be considered to explain what is observed.

Within this study, observed actions by the participants were logged by their specific actions or errors made. There was no theory created as to why they took the actions they did until they actually identified these reasons either in the debriefing or within their writings. Replication of these observations among multiple students participating in the simulations aided in reinforcing what was actually observed. This replication occurred horizontally from simulation to simulation and vertically from year to year by different cohorts of students. Throughout the study, alternate reasons for student behavior were constantly discussed by the co-instructors; however, like Occam's razor, the assumption of truth was based on the least complicated and simplest solution

presented—the students told the truth, thus what they identified as the reason for their actions was the reason for their actions. Replication among different student cohorts in similar events aided in increasing the internal validity of this research.

### External Validity

External validity in case study research refers to whether or not a study's findings can be generalized beyond the specific case study (Yin, 2009). Sometimes this is also called generalizability (Marshall & Rossman, 2006). Replication of results from other similar case studies can help establish the external validity of a case study. This is particularly true when theories or models are developed within a specific case study.

Within this case study, within the literature review section *Previous Similar Studies*, a number of similar studies such as the Clendinneng (2011), Conejo (2010), Kuznar (2009), and Van Horn (2000) reported on the student learning that occurred in the parallel nursing field in simulation studies. Some of that same learning was reported in this study with paramedic students both adding to the external validity of this study as well as those previous ones listed. As some of these results are replicated in future studies, the external validity of this study will increase. One of the strongest factors will be the decisions of future researchers in choosing what elements of this study to replicate in their work. In a sense, the choices they make have a direct impact on the external validity of this study.

### Reliability

Reliability in research is defined a number of different ways. Overall, reliability refers to the ability of a later researcher to follow the same procedures described to

achieve similar results (Yin, 2009). In quantitative research, reliability is computed statistically as a measure of consistency between different raters, tests or instruments. In qualitative research, reliability is estimated base on researcher and/or expert estimation of consistency between observers or observations. Inter-rater reliability is the agreement between different individuals viewing the same data. Intra-rater reliability is the agreement between repeat events viewed by a researcher.

There were several ways this study attempted to improve reliability. These include: (a) the development of case study protocol to prevent documentation problems; (b) the use of a case study database; and (c) careful documentation of the specific methods used within the research so that future researchers could duplicate the results. The starting point in this protocol was to develop overarching questions and determining the best evidence to collect to address these questions. Given the accumulation of audiovisual recordings over several years, these recordings became a baseline for data analysis. These recordings had the briefings, debriefings, and simulations, and showed student results within the specific modules and created a natural link to other data. These were put into a database to facilitate consistent analysis. I kept track of this analysis and worked with advisors to make sure specific methods were used.

### **Ethics and IRB**

This research directly deals with the use of human subjects in the exploration of its questions. Because students were involved in this study, several ethical issues needed to be addressed. In addition, approval from two independent review boards was required for the study to proceed. In this section I will discuss these issues.

One of the earliest ethical concerns was in determining the methodology for this study. At one time, consideration was given to establishing a comparative study where one population received the treatment (simulation) while the others did not (control or traditional clinical only); however, preliminary results in the literature and with prior cohorts to the study had shown that simulation improved their abilities. Because the simulation was embedded in their studies, there would be no easy way to replace the missed learning opportunity for the non-treatment control group. This methodology was abandoned on ethical grounds. Case study format was selected as the best way to safely explore the questions.

Confidentiality of the subjects was a major ethical concern. Within this study, it was known that I would be embedded and work closely with the group. Because of this, when feedback from the students was sought in written format, a double-blind technique was utilized whereby I did not know the names of the respondents on feedback documents until the end of the study. The names were not revealed by an independent instructor who collected that information until the end of this study. By doing this, the likelihood of the principle researcher singling an individual out for retribution was impossible and students could confidently give their true feedback with impunity. In addition, all names of students were changed to letters (student A, student B, etc.) within the data collection, supporting confidentiality.

Regarding participation, all students were required to participate in the simulation exercises as part of the required coursework in becoming a paramedic; however, they were not required to participate in the study. At the beginning of the school year, an introduction module contained a lecture where the study was discussed. Students who

were interested in participating in the study were required to sign a consent form that was explained fully as part of the study disclosure. They were clearly informed that they could opt out at any time even after the school year completed. Each student was required to sign the consent form found in Appendix B. Over the 4 years, no students opted out of the study and several have requested email copies of the completed study. No remuneration was offered for participation in the study. It was represented as an effort to potentially provide research that might improve future EMS education.

Independent review boards (IRB) existed at both Kellogg Community College (where the study occurred) and Andrews University (where this dissertation originated). Application to and approval from both was required to proceed. Appendix B contains those letters of approval to proceed with this research.

## CHAPTER 4

### FINDINGS: CONTEXT OF LEARNING

#### **Introduction**

This chapter reviews the processes and learning involved in creating the context of learning. Chapter 4, Chapter 5, and Chapter 6 describe the findings and detail the data that were used to develop them: Chapter 4 creating the context for learning, Chapter 5 summarizing the quantitative data collected, and Chapter 6 describing the qualitative data from students and instructors alike. Following this, I then spend the bulk of Chapter 4 in the *Timeline* section, detailing the context of learning which was created by the EMS faculty at Kellogg Community College.

Understanding this context of learning is central to later understanding the students' reported learning. I explain the beginning of the program so that the reader can understand how lessons learned in the first 2 years of revising the EMS program factored into simulation redesign. I detail the formulation of the simulation experience and curricular and instructional decisions on the level of fidelity, design of simulations, use of technologies, and related issues as well as the trial-and-error processes used to help create the learning context.

#### **Timeline**

This study reviewed educational data collected from a 4-year period; but in reality, the program was building up to a new learning context even before that. This

section describes some of those key events that slowly led to more aggressive changes to the EMS educational environment. It starts with the inception of simulation within the EMS program and ends with the conclusion of year 4 in the study.

### Initiating Simulation Into the EMS Program

Prior to the implementation of this study, the EMS Program at Kellogg Community College had engaged in what would be best described as low or limited to medium fidelity simulation. Students would practice various techniques on individual task trainers as part of a simulation in which they were asked to ignore the classroom setting and pretend they were in a different setting such as a factory, field, roadway, etc. During this time, they might perform airway tasks on an airway task trainer, intravenous cannulation on an IV arm separate of the airway trainer, and perhaps extrication from chairs simulating a vehicle using a dragging manikin.

During this time, a desire to see students get more experience led to the purchase of one Laerdal SimMan manikin. This gave us the ability to start IV's, listen to breath sounds while the manikin was breathing, intubate, ventilate, perform defibrillation, electrophysiology of the heart, and several other features all in one manikin. Prior to this point, affordable manikins of this quality were not available. There was one major drawback: The SimMan required a dedicated wired computer along with a wired patient monitor in order to operate it. It also required a 110-volt compressor attached to the manikin. This tether resulted in drawbacks to its use and always required that the instructor be within 20 feet or less of the manikin. Also, the noisy compressor often interrupted procedures for the students including the auscultation of breath sounds.



Despite its major drawback, it was an immediate improvement in the quality of the simulations; however, it was a start in creating more simulated experiences for students.

Students were soon seen performing scenarios on one manikin instead of separate parts using task trainers. However, these were still occurring in the middle of or in front of a classroom setting. The realism still required intense use of the imagination—something that many students had difficulty with.

As instructors noticed students straining to use the manikin, more effective integration was starting to be developed. A decision was made to improve the environment by demounting an ambulance passenger compartment from the chassis and installing it in a classroom lab setting where the students could physically experience the close quarters and resources they would have in an ambulance.

The theory was that if the setting was more realistic, maybe the simulation with the manikin would be as well. Because the passenger compartment limited the space, it was decided to pull the instructor out of the ambulance and allow them to view the simulation using pre-mounted security cameras. The front of the ambulance was replaced with a control cab and the observation and compartment controls were located in this section. Finally, the computer which drove SimMan was relocated into the front cab so that the instructor could view and control the scenario from one place.

Simulation was slowly moving from an instructor-centered classroom environment to increasingly more high-fidelity simulated environments. Students reported that the experience seemed more real and comparable to those they experienced in actual EMS vehicles. Students emotionally seemed to respond to this environmental shift by becoming more engaged and even to the point of having fierce arguments over

the treatment a patient needed. This convinced some instructors that simulation was having an impact.

Learning appeared to be occurring at multiple levels including psychomotor, affective domain, and cognitive, especially in critical thinking and sequence skills. In subsequent discussions, students often remarked how real they felt it was and how much they were forced to apply what they had learned to real-life situations. It was clear that learning was occurring, but what was unclear was why? What were the specific things that caused the actual learning? Why did it happen? Could it be improved? What was actually being learned by the students? While simulation appeared to be an effective learning tool, it also had created more questions than answers. A major question was, “Could high-fidelity healthcare simulation be used to educate EMS practitioners?” If so, how?

### Video and Feedback

Video recorders were soon added to the ambulance but originally mainly for the instructors to analyze the students’ performance; however, occasionally they would be viewed by the students as well. When these were shown to students, it was often done in a fairly time-consuming way. Typically, it required either playing the entire tape or searching for specific segments previously marked by the instructor. However, even this clumsy approach seemed to have value in that students would see their behavior and comment on that behavior from a new perspective. “I didn’t know I did that.” “That was dumb.” Or other phrases suggested they were seeing something they had not seen before.

All this was working to increase instructors’ awareness that there was some new type of learning going on both in simulations and in watching simulations.

What was learned in these early stages of high-fidelity healthcare simulation was that there could be more effective learning from these experiences; however, having all the learning take place in the back of an ambulance with “patients” who were already loaded was giving only partial experiences. Often, the bulk of the work and data obtained by EMS crews occurred prior to entering the physical ambulance. So, instructors (mainly myself) started to work on ways to possibly capture other elements of learning by designing new ways to do simulation.

As I was evaluating pre-ambulance simulations, I also realized that EMS providers must also learn to participate in the organized hand-off of the patient in the Emergency Room or care setting. Could this, too, be simulated? A decision was made to construct an Emergency Room using simple partitions along with a living room and bathroom within the lab. These were wired with video cameras and equipment to allow for capture of these segments of a typical ambulance call. A new wireless manikin was obtained which offered the features of the SimMan, but without the wires (Gaumard’s HAL manikin). This allowed for a simulation patient to be moved from the house, to the ambulance, and then the ER without the clutter of wires being unplugged and re-plugged.

### Questions Emerge

Instructors began to use the simulators for various simulations. Elements of calls were analyzed and students’ satisfaction in the learning process appeared to improve. Even though the physical simulators had improved, and the environment was increased in fidelity, the questions kept emerging, “Why are they learning? How are they learning? What is happening here?” These questions began this research project.

## **Year 1: The Alpha Year**

### Integrating Simulations Into Programming

These early experiences were teaching the program instructors, especially me, to start thinking of ways that simulations, videotaping, and feedback were influencing learning. I developed some hunches about how paramedic students might be learning in a high-fidelity healthcare simulation environment through their experiences, the audio/video recordings, and instructor-facilitated feedback I was starting to assimilate into their simulations. These hunches, or what Creswell (Creswell, 2007) might identify as hypotheses, served as both useful guides to thinking about the program as a teacher and also in helping me as a researcher to think about effective learning. One hunch was that creating a more realistic environment would result in greater immersion by the student into the real-world setting which they would have to function in as graduate paramedics. Second, I felt that if I created many diverse scenarios I could put students in situations and physical positions where they would have to make critical decisions and work together on solutions. This led to the third hunch that as they would continue the simulation, this experiencing and then reflecting on the consequences of their actions, good or bad, would generate new learning. For this last hunch Kolb's learning theory in which experience processed by reflective observation, conceptualization, and active experimentation results in learning played a key role (see Chapters 2 and 7 for more discussion of this theory).

During this same time, the Institute of Medicine published the study *To Err Is Human* which investigated the high cost of medicine in human lives due to human and systems errors (Kohn et al., 2000). It was known that EMS were not immune to human

and systems errors. Team training, such as in programs like TeamSteps, was being introduced into medical education to help create more learning through team dynamics. Could these same solutions be implemented in EMS?

In addition to using teamwork dynamics to decrease errors, I also began to see that students were told in EMS training to lead but were not often taught *how* to lead. Could the program do that as well? How? And how would that be related to the simulation training that was being planned?

Paramedics were having a difficult time within this program experiencing all of the required clinical experiences especially in specialty areas. This was not unique to the KCC program and was occurring nationwide (Salzman et al., 2007). Within the Paramedic National Curriculum (NHTSA, 1998), simulated experiences were allowed to aid in experiencing the competencies required for graduation. Could these also be incorporated into the simulations?

In defining the unit of analysis, it was clear that teamwork and leadership are important elements in managing a typical EMS call. Studying a specific individual within a team would be difficult since their actions are influenced by those around them who are experiencing the same situation. For this reason, it made sense to analyze each team as a unit following each simulation, looking for commonalities between teams in their experiencing of the scenarios. For analysis purposes, teams would be debriefed within the simulations. All simulations, briefings, and debriefings would be audio/video recorded for later analysis.

The logic in linking the data to the propositions occurs within the analysis of the data itself. As the video recordings are reviewed, common themes would emerge that

would be used to answer the original question, What and how is learning occurring? These themes would then be combined to answer the original questions.

Finally, the criteria by which this would be measured was the reliability of the repeated simulations over the years to reinforce common themes which emerged from the debriefings, interviews, and study of the participants' behaviors. If replicated, would another researcher find similar conclusions to what has been determined within this group? What lessons can be learned based on the sampling that was found here?

These hunches were moving the program into the generative phase of experimenting with new ways of doing things.

#### Transitioning to Better Program Designs

It was known that this study would take several years to conduct. Year 1 was considered a pilot year in testing many of the constructs within the study. There were many questions regarding the specifics of the design for this study. What was the best method for designing the simulations? Where would these be placed within the paramedic curriculum so as to best augment the teaching? How would briefings, simulations and debriefings be conducted? Where would these be conducted and when? What format would be used providing feedback to the participants? How would the technology work to allow for capture of the data? All of these questions and more needed to be addressed to design this study.

To begin, an in-depth review of the literature was performed looking for answers to the above questions. Many sources for core information were referenced to develop the simulations used. Sources included the Society for Simulation in Healthcare, studies based on the aviation industry's crew resource management (CRM), and various medical

journals. TeamStepps, Kolb's Learning Theory, and Emotional Intelligence Theory were chosen to aid in the design of the simulations. Finally, all work needed to be compatible with the paramedic curriculum as the participants within this study would be attending that program of study.

It was known that simulations needed to have a logical start and end point. From a practical standpoint, in analyzing an EMS call, the start point is receipt of dispatch information and end point is the hand-off of the patient with report to the next care facility and healthcare providers. Scenarios would be written with this in mind.

The decision on what specific scenarios to design was made based on an analysis of the clinical competencies that were obtained in previous years. During these times, certain competencies were tested because there had not been enough opportunities in the clinical environment to obtain the number of competencies required. A prioritized list of most- to least-difficult-to-get competencies was made. Specialty areas such as pediatrics and obstetrics were at the top of the list along with some adult un-intubated ventilations. The first designed sims would cover these topics.

The format for the simulations was patterned after those used in aviation and previous medical simulation studies. Each simulation was given a title based on the primary medical condition that would be encountered. Specific teaching objectives were identified related to that medical condition from the *Paramedic National Standard Curriculum* (NHTSA, 1998). A description was written which gave an overall step-by-step outline of the information and actions that were expected within the simulation. Required equipment and personnel were procured.

The simulations were divided into logical blocks of information similar to the storyboard for a play or production. Each block represented a segment of the overall simulation, often divided by its specific simulator location. For example, event set one might be the initial scene of the accident, an apartment room, bathroom, or public area. The specific information to be given to the crew at various points in the simulation was divided up in the event sets. Often, the information or patient's condition will change over time. This was reflected in the event sets. Any distractors were also defined here. Distractors were used to complicate the team management and potentially dislodge the proper course of treatment for the patient if not managed by the team leader. These represent a real occurrence from the pre-hospital arena.

Each event set was followed by a list of expected behaviors that should be observed by the team. These were divided into primary topics of communication, initial assessment, secondary assessment, management of the patient, and situational awareness. Subdivisions under each of these primary topics included the specific items that were to be performed. Each item also contained an element of importance based on the scenario presented. Appendix A shows an example of one scenario script.

Each scenario had reference materials at the end in the form of appendices. These often contained the specific protocols, based on the *Michigan Department of Community Health Standardized Protocols* (Michigan Department of Community Health, 2011), along with any of the information or graphs that might be of help to the facilitator during the debriefing. Also contained in this last section was programming information for any manikins used during the simulation.



A total of six modules was designed for the prototype year, which contained an adult COPD patient, adult asthma patient, adult congestive heart failure patient, adult terminal patient with Do Not Resuscitate, pediatric asthma patient, pediatric epiglottitis, pediatric febrile seizure, pediatric drowning, pregnant patient with eclampsia, pregnant patient with an umbilical cord presentation, normal cephalic delivery, a limb presentation, and a pregnancy with *placentae previa*. The breach delivery was developed but not used due to time constraints. In total, 13 scenarios were developed and used in the first year over six modules.

In timing the schedule of simulations, no simulation on a specific medical condition would be presented unless it had already been discussed in the didactic lecture within the program. A close monitoring between the lecture, lab and simulation instructor was maintained so that simulations were consistent with the information presented. Students signed up for the simulations, which were scheduled to be most conducive to their class schedule. It was unknown exactly how many students were an optimal number to participate in simulations at one time. Groups would be varied in the first year, consisting of between three and six students per module. Based on a review of the performance in the simulations, this number would be changed as appropriate.

Several simulators were built for the purpose of simulation. The ambulance simulator was previously described. In addition, an apartment or bedroom simulator was built with an attached bathroom. Two vehicle simulators were built for use in extrication training. These were modified vehicles with the glass, engine compartment and trunks removed to minimize the space used. An Emergency Room was constructed, which allowed for hand-off of the patient to the Emergency Room. This room could also be

modified to serve as a hospital bed or setting. Each simulator had its own control systems and console that allowed for control of the simulations and manikin.

In earlier simulations, videotape was used to capture the simulations. This was a known drawback as it was difficult to use with a group in a time-effective manner. In *Facilitating LOS Debriefings: A Training Manual*, it specifically states, “Do not show a video segment unless you intend to discuss it” (McDonnell et al., 1997, p. 25). Often, during a debriefing using videotape, this was difficult if not impossible, since it required scanning through in fast-forward to find a specific segment.

Given the earlier problems with videotape, the recording system was upgraded to a digital one that was computer based. The new system from KB Port LLC allowed capture of four video cameras and two patient monitors simultaneously with audio. In addition, a time-encoded play system allowed notes to be tagged to specific points on the video. In debrief, these could be recalled by selecting the note. Once selected, the clip would play from that point. This allowed for more control of what the students saw during the debrief, minimizing distractions or ineffective use of time.

The first year’s data collection proved both challenging and a learning experience for all. It was expected that this year would have challenges, given all of the new systems, approaches and methods being used within the study. At the end of year 1, several things were known.

First, the new electronic data collection system worked, although there were technical challenges with it. During data collection, the recorders had a habit of shutting off at between 25-30 minutes when capturing video, monitors and tagging data. This didn’t happen during the debriefings where no monitor capture occurred. There were

other technical problems as well. On several recordings, there was a double-speech sound as simulations occurred. While the audio was able to be understood, it was not as clear. This seemed to be a random but persistent event. Backing up data also proved challenging at times. Updates to the software over the first year alleviated many of the technical errors.

Second, camera placement and the ability to see different things occurring proved challenging at times. Several camera placements were changed as a result of this. Often when the students would huddle around the patient, performing various skills and techniques, it was unclear exactly what specific steps they were taking or if a skill had been completely performed. Knowing whether or not the oxygen was on or off when applied to the patient was one example of this. The mask could be seen in place, but whether or not the actual gas was flowing was more difficult to verify, especially if the hissing sound was not clearly audible.

Third, within the scenarios, because of how the simulators were wired, when moving from one simulator to another simulator, there was a “freeze” time in which students had to pause while the next simulator was started and control of the manikin was switched from one computer to another. During the simulation, it was found that students felt the experience was really happening and were willing to participate in the *suspension of disbelief* during the scenario; however, due to the technical limitations created by the need to pause the simulation between simulators, the students found themselves removed from this immersion. As a result, they were able to start self-reflection of their actions both alone and with others. This resulted in changing their course of actions in the continuance of the scenario. It also resulted in a lack of realism for a brief time while

students attempted to regain their suspension of disbelief. Most scenarios had at least two pauses within them. We attempted to use the ambulance portable cameras in the ER simulator; however, this too created technical problems. During the first year, there was no easy fix for this problem.

In addition to the problems associated with moving from one simulator to another, there was a significant loss of time experienced by the students while technical issues were resolved. This loss of time was caused by two separate factors. First, the researchers did not have a well-organized system for dealing with the rapid responses of the students in a scenario. Within a scenario, often the students would decide to move forward with a scenario or a component of a scenario prior to it being expected by the operators. Quickly it was realized that to adjust for this, two instructors were needed with overlapping coverage on the tasks to be done. Often one instructor would be responsible for the manikin or informational roles while the other instructor was engaged in coding the simulation for later facilitation during the debriefing. While this methodology fixed some of the time lags, it did not fix all of them.

The second loss of time was caused by the technology itself. Because the simulators evolved, each was set up with its own cameras, computer to control the manikin, computer to control the patient monitor, and recording computer. In performing the actual simulations, this was a fatal design flaw. Besides the required booting of simulators and computers, and the down time switching from one simulator to another, there was also time lost in technical glitches operating the manikins. Some of the lessons learned included understanding conflicts in the wireless technologies, dealing with the sequential requirements of the technology, and testing everything before giving the

“unfreeze” command to the students or starting the simulation. Having several different computers operating that needed to be sequentially stopped and started to move from simulator to another simulator was a fatal time killer during the simulations.

Some of the manikins used in the first year of simulations, particularly Noelle, did not have the capability for producing wireless speech for the students to interact with the patient. This became a major issue in the simulation since her voice was either heard overhead on the environmental simulator or by a facilitator present in the room. Quickly, the problems were obvious and a wireless system was installed in the chest of the manikin to allow for a muffled but understandable voice. Later, the manufacturer of the manikin upgraded it in the second year to have streaming audio through the standardized control systems. This feature alone was as important as any physiological one as it was often the first interaction most students would have with the patient.

Instructor observations and feedback from students in debriefings told us that there was confusion for them in simulations when a single communication device, such as a walkie-talkie, was simultaneously used for communications from the patient, dispatch communications, and sim operator communications working through a simism. This became a major issue in some simulations within the first year. In that year, two-way walkie-talkie-type radios were purchased and given to the crews for communications with dispatch, mimicking what they would normally carry as an EMS worker; however, during the simulations, when something went wrong or created a simulator-based problem, the same communication walkie-talkies were used to communicate with the students. This caused confusion on whether or not they were communicating to dispatch in a simulation or the facilitator working around an issue. Using the crew radios for

anything other than dispatch-related activity decreased the fidelity of the simulation by adding a layer of confusion for the students. After the first two modules of the first year, an overhead speaker was added into each environmental simulator. This “God” speaker, as it was affectionately labeled by students, prevented communication confusion issues. In the case of the Noelle manikin, the addition of the streaming voice, similar to the HAL manikin, crystalized communications for the learners. One of the learning points from these experiences was that to maintain the fidelity of the simulation experience, the communications device, whether it be a radio, phone, manikin, or from the simulation operator, needed to be the source of that communication in the simulation.

Finally, in the first year, students were given a 30-40-minute time at the beginning of each module to check their equipment on their ambulance. This, too, consumed time as not all groups were able to perform this task even given a full hour. The result of the first year’s preliminary data collection was that within most modules we were able to successfully conduct one briefing, two simulations, and two debriefings within a 4-hour block of time and often took longer. Students voiced concerns over the amount of “down time” within a simulation day.

One last issue that was experienced was a lack of normal human feedback mechanisms by the manikins to the students. Only the adult male manikin had the capability to produce an audio voice from the sim operator. The pediatric and obstetric manikins lacked a voice completely. The facial expressions on all manikins was fixed so that students performing the simulations were unaware of the communication that might have taken place by the simulated patient. Within the obstetric simulations, a voice was added to the manikin to allow communication via a simple walkie-talkie and this aided in

communications. Still, the lack of facial expressions was impossible to simulate using the current technology.

In analyzing the data, several themes emerged which would force the planning into the design phase for the second year. First, the “down time” needed to be decreased. In analyzing the data, it was not unusual for 1 hour of the 4 hours to be spent in “down time” for the students where they were waiting for some issue or condition to be resolved in order to proceed with the simulation. Second, a better method was needed to control the simulation and recordings during the simulation. Changing computers from simulator to simulator created a lot of the “down time” experienced by the students. It also complicated the operation of the simulation while decreasing the reality experienced by the students. Third, better control over the video as it was being captured needed to be gained. Often, even when using four cameras, action occurred that was outside of the field of capture. This needed to be fixed.

Throughout the scenarios in the first year, a common theme that also appeared was the lack of familiarity of where specific equipment was in the simulation lab. Though the students were given time to check out the equipment at the beginning of each module, often they did this separately and divided up the workload. As a result, not all participants were aware of where everything was located.

In viewing how many students should participate in a simulation, an interesting event occurred. Groups of three lacked the number of students needed to act as two separate teams. The minimum number appeared to be four. Less than this resulted in less getting done for the patient. Groups of six or more encountered an opposite problem. Too many on scene created difficulty in seeing what was happening and decreased their

individual “hands on” the patient or experience in performing skills. A recommendation for the next year would be 4-5 students per simulation.

I received a lot of feedback from the students in year 1 both after the simulations and during the debriefings. One of the feedback items that kept coming up was that they were experiencing in simulation the calls that they weren’t getting in the clinical setting. I realized that it wasn’t just one person who was getting that experience—they were all getting the experience. One of the advantages I saw in simulation is that all students were exposed to the same experiences. This can’t be controlled in the clinical setting since the types of calls vary depending on the injuries or illnesses of the day. In the simulation lab, it was totally controlled. I began planning additional learning experiences through simulation for the next year.

In many ways, year 1 was the year of learning for the instructors, myself included. We didn’t know what we didn’t know. In hindsight, I now refer to this year as the alpha year since it showed us the context-design flaws and issues that needed to be resolved. There was a lot of experimentation in this year, trying to get the context right. Year 2 would enter into the first true beta test for collecting data; hence, I called it the Beta Year.

## **Year 2: The Beta Year**

During the second year, several changes were made. First, a video switcher was purchased that allowed all of the inputs from the various cameras to be switched to a generic station in a central control room. This video switcher eliminated the need to have three sets of four computers booted in succession and instead utilized one set of four. By doing this, a significant amount of “down time” was eliminated. This required rewiring of



the simulators and occurred by the mid-point of the second year. This rewiring would need to be done while the sim lab was still in use for classes, which created a challenge.

Pan-tilt-zoom (PTZ) cameras were added to some simulators which allowed for one camera to focus and zoom in on an activity. In doing this, a better understanding of exact actions could be gained. Along with the installation of PTZ cameras, additional cameras were installed into some simulators where views were an issue. The ability of the new switcher to move from one camera to another allowed better flexibility.

Technical problems with the recording software were fixed by software patches released by the vendor. New streaming audio, or the ability of the manikin to talk, was made possible by an additional module installed in the manikins, whether they be adult or pediatric. There still remained a problem with the facial expressions being fixed; however, this was also improved through the addition of blinking eyes and pupils that reacted to light similar to humans. A final change occurred in the use of Post-it notes on the manikin to describe items that the manikin could not simulate. The term *simisms* was used to describe problems in the simulation that could not be easily simulated. Within the briefing, these problems were added to the repertoire of slides to warn students about anything they might encounter.

#### More Scenarios Added

In the second year, the full complement of 11 modules was planned, nearly doubling what had been done in the first year. In addition to the first year's scenarios, the following additional scenarios were added: pediatric trauma and refusal to allow transport, adult tuberculosis, adult multisystems trauma (leg amputation with a head injury), adult bi-polar episode, adult depression episode with the risk of suicide, adult

sick person with influenza, adult cardiac arrest, adult syncope on toilet, geriatric fractured hip, pediatric shooting, and a revisit of the earlier COPD simulation. For many of the modules, a theme was present which represented the scenarios contained within it. For example, the Pediatric One module would contain all pediatric scenarios, the Obstetric One module would contain all obstetric-related scenarios, etc. There were some modules that were mixed. In those situations, students did not know what they were entering prior to receiving the call.

Several of the simulations were impossible to simulate with a manikin due to the lack of movement and human interaction required. These were the adult depression and bi-polar episode modules. In both cases, a standardized patient actress was brought in who acted the roles.

The first module was divided into a lecture and lab portion of 4 hours each. In the lecture portion, the students received a PowerPoint presentation that described the reason this was being done, what some of the theories behind it were, what they should expect, confidentiality, and the fact that it was part of research. The lab portion contained a scavenger hunt which each student needed to complete in order to familiarize them with the locations of various pieces of equipment and supplies in the simulation lab. Following the scavenger hunt, students participated in their first scenario.

#### Learning From Related Industries Applied

Also, during the second year, with the addition of new technologies, better systems were developed between the sim operators to decrease “down time” during and between scenarios. Copying from the aviation check-list functions, prior to starting a simulation, the operators would go through a brief checklist to make sure that preventable

sources of failure were minimized. This was learned from the first year's work. With the new equipment in place, there were no pauses between the different simulators and action continued in real time. The plan was to decrease the down time in year 2's simulations.

Year 2 data collection went much smoother than for year 1, especially once the new switch and wiring were completed. The process of simulation became more systematic. Because of fewer issues with the technical problems experienced in year 1, the focus became more on the quality of debriefing and measuring the learning that was taking place. In short, year 2 was the first year that allowed for actual focus on the process of learning unimpeded by the technology.

#### Debriefing Improved

In the second year, in reviewing the data, a number of common events were occurring in simulations. More effective debriefing techniques were developed in the second year. Some could be explained, yet others were a mystery. One recurring theme was that often an entire group would be staring at a problem and not recognizing that it was there. This was witnessed over and over in the simulations. In TeamStepps terminology, they had poor situational awareness of the event; however, that alone didn't fully explain what was taking place. Out of year 2's analysis came the call for additional research. This would eventually yield a possible theory into what was occurring, thanks to the research by Chris Chabris and Daniel Simons (2010) on inattention and change blindness. At the time, this was not known.

In year 2, student feedback was overwhelmingly positive towards the use of simulation as an education methodology. Within the follow-up questions, students overwhelmingly indicated that they recommended at least two more modules in the

second semester. Based on these recommendations, two additional modules were added for the third year of the program.

Students in year 2 began realizing that if the first scenario dealt with a topic such as pediatrics or obstetrics, the likelihood of the next scenario dealing with the same problem was greater. In some situations, this created a guessing on the student's part of what the next call might be. This became a realized problem in the way the scenarios were conducted and a simple solution was to mix up the scenarios more rather than to keep them in common themes.

Technology, though improved, still presented some significant challenges in the second year. The new video switcher was found to have intermittent problems by freezing during a simulation. This prevented the video feeds from being switched from one simulator to another, defeating the purpose of the switcher. Backup methods were employed; however, the intended design and actual function of this technology did not always meet and were the occasional cause of delays during the simulations.

In addition, at the end of year 2, a decision to move the simulation lab was made by outside influences not related to the program. The move presented opportunities to further improve the quality and ease with which simulations could be conducted, including a refinement to the problematic switcher. These would be represented in the year 3 design changes.

### **Year 3: A New Sim Lab**

In the third year, the entire simulation lab was moved during the first 8 weeks of the students' program. Normally, simulations did not occur until the second half of the first semester to allow the students to learn the skills and the knowledge base that would

be applied in the simulations. In the new lab, additional simulators were added, which included a pediatric hospital room, a centralized control room, a second ambulance simulator located outside, and a multipurpose room. The multipurpose room could be redefined as a hospital room, day care center, homeless shelter, and more for the purposes of the simulation.

The centralized control room allowed for the simulation to be controlled totally outside the simulator and outside the view of the students. All viewing was through the monitors in the control room. The controls in the control room allowed for easier switching between simulators by using fewer keystrokes due to improved technology. An overall more professional appearance existed with all of the equipment and facilities. A secondary debriefing room was added to the lab.

#### Simulations Added

Two additional modules were added to the schedule based on feedback from the students in year 2. Additional scenarios included an adult narcotic overdose, trauma-induced miscarriage, and an adult smoke inhalation with multiple patients. Rather than have specific days for obstetrics, pediatrics, or other topics, a decision was made to mix the scenarios in all simulations, which would better represent what was experienced in the field. It would also be less predictable for students.

In preparing for the third year, movement to the new simulation lab required a number of simulation materials updates. The scavenger hunt was updated to reflect the new simulation facilities. Props needed to be changed to reflect new locations. Additional training and practice were required for the simulation operators to conduct simulations in the new facility, since many of the controls were different. While the facility was new

and improved, it was known that a lot of technical glitches might be present that required correction. Throughout this process of fixes, the simulations would continue. Some new simulations were written and changes were made in existing simulations to allow them to be conducted within the new facilities. The core content of the existing simulations did not change; however, the new simulations allowed for additional competencies and experiences lacking in the clinical setting. The introduction lecture was modified and expanded to remove information for the later briefings in simulation.

Towards the middle of year 3, I added an iPod that piped in sound effects to the environmental simulators. By doing this, when the ambulance drove from the scene to the ER, the sounds of road noises either with or without sirens could be added. Students were surprised how much this added to the transport reality. Most paramedics will state that the sounds from a roaring diesel motor and siren blaring to clear traffic interfere with effective communications—whether that be with the patient, on the radio with the hospital, or to other team members in the back of the ambulance. This provided another realistic element to the simulations.

### Specific Clinical Site Shortages

In the third year, a shortage of available clinical sites for students to experience traditional clinical experiences began to occur in some areas including pediatrics, high-risk obstetrics, and mental health experiences. The availability of simulations to provide clinical experiences for competencies became a vital component of the program so that students could achieve the minimum number of clinical experiences to attain their overall competencies. Simulation was no longer an option but, instead, a requirement.

### Prioritization of Scenarios

A reclassification of the scenarios also occurred. Within the groups, it was discovered that based on individual group needs and errors, some groups might get two scenarios completed while others got three. Because of this, scenarios were identified as primary or secondary, based on the importance of getting that material to the learner. Primary simulation scenarios were required to be completed in that module. Secondary scenarios were optional. If there was time, they should be completed to give additional practice; however, core content would not be missed if they were not performed.

### Data Collection Improved

Data collection occurred during the third year with little difficulty. Year 3 marked the first time that full data collection could occur. This included pre-simulation assessments of the students, student evaluations of the scenarios, run reports, and more. This data collection would allow for a better understanding of how students learn within this environment.

In year 3, I experienced a number of technical glitches. For a semester, some of the audio recordings were difficult due to grounding issues that were later discovered. The result of this was popping and buzzing sounds on playback of the audio in some simulation rooms. The fixed-mount touch monitors used for accessing patient vital signs were not able to be programmed by students due to the current technology. The hand-held patient monitors, used by the students, worked sporadically. While this decreased the fidelity of the simulations, the monitors did supply the necessary data with help from the simulation operators.

In analyzing the data, it was very evident that the process of simulation that had been adopted had become very efficient and effective. Year 3 was the smoothest year yet in simulation and allowed for a focus on accurate data collection not impeded by technology or design. The technology glitches requiring correction did not impair the simulation experience for the students. As the data were analyzed, it was apparent that there was some additional information needed from the students. This would result in adding some elements to the design in year 4.

#### **Year 4: Deeper Questions Emerge**

In the fourth year, there were no major changes in the environmental simulators or simulation process. Year 3 had worked the glitches out of the improved technology; however, there were questions about what the students were and weren't aware of regarding the simulation process itself. How did they view this process, if given a seat in the control room? Was there additional learning that would occur from this vantage point that would be different for the students? What would they see if viewing this process? What would they learn?

#### **Additional Data Collected**

As a result of the questions I had, in the last few modules, I began having a student sit in the control room during every module to experience the simulations from that vantage point. They were instructed to keep a log on what they saw and experienced in this unique position. This role was rotated between students until all had experienced this vantage point. These logs were collected and analyzed.



In addition, a more specific evaluation log was developed that allowed the students to submit their experiences electronically. The identity of these students who produced these logs was kept from me until after the year had ended. This double-blind technique allowed for the most genuine feedback.

In preparing for the fourth year, the scenarios and materials used in year 3 were found to be very effective. Outside of minor typographical errors, little was changed in preparation for the last year of data collection. The context to the simulations had been well established.

The last year of data collection occurred without difficulty. All scenarios and debriefings were recorded and the data analyzed. The additional pieces of student observation of a simulation and their weekly evaluations were added to the data collection.

The analysis of year 4 proved to give insights into learning that weren't achieved in the first 3 years. In year 4, a lot of previous observed patterns in the data such as the types of errors observed, learning methods, student comments, and other information began to become repetitive in nature. In essence, I was seeing the same information reconfirmed that will be presented in Chapter 5. In the end, there was a saturation to the overall data collected.

### **Context of Learning Summary**

In Chapter 4, I presented the context of this research along with the many lessons learned by the instructors, myself included. The focus has been on the process of simulation to get the context correct for this study. That being accomplished, in Chapter 5

I present a summary of the quantitative data followed by the qualitative data in Chapter 6.

Once presented, I will answer the overall research questions in Chapter 7.

## CHAPTER 5

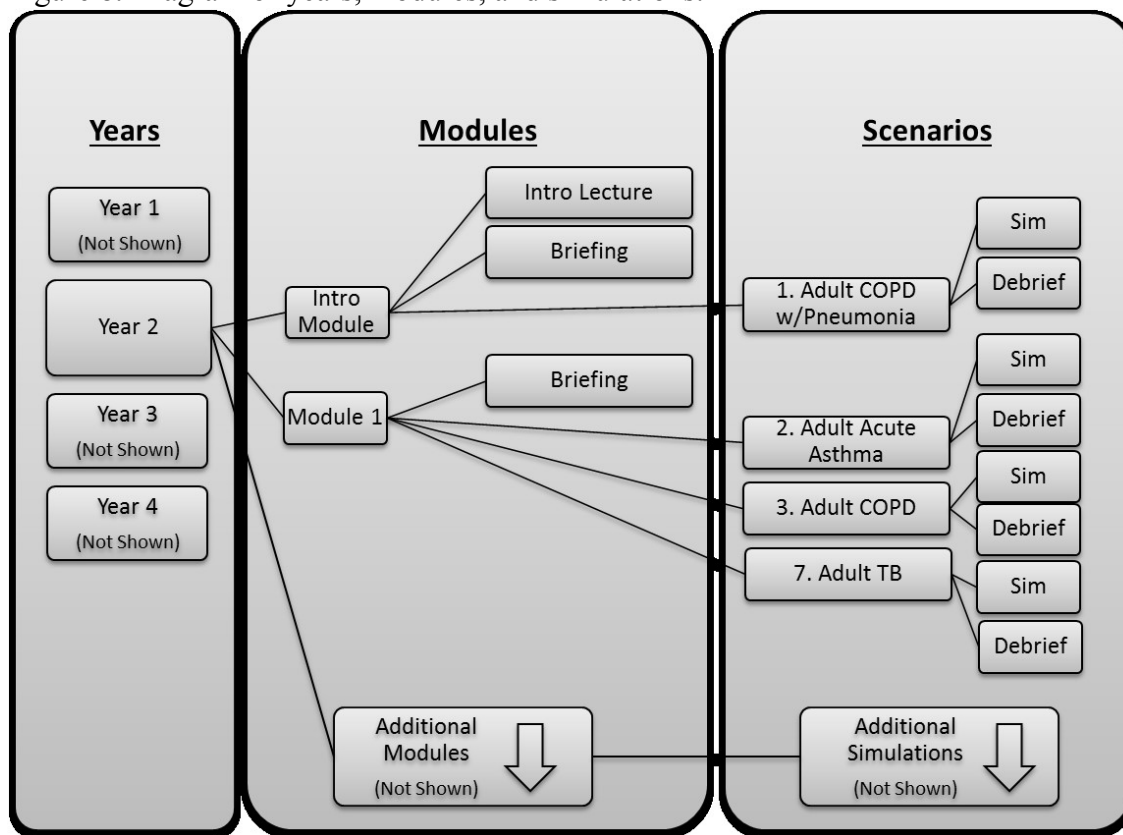
### FINDINGS: QUANTITATIVE DATA

Within this mixed methods study, while primarily qualitative in nature, both quantitative and qualitative data were collected. In this next section, I will present the quantitative data that describe the quantity of simulation experiences, briefings, simulations, debriefings, and some calculations regarding simulation efficiency.

#### **Simulation Conducted**

This study occurred over 4 years. Each year consisted of modules that contained a briefing and two to three simulation scenarios. Each simulation was followed by a facilitated debriefing. Figure 8 clarifies the relationships between years, modules, briefing, simulations, and debriefings. Most modules were identical to the structure of module 1 in the diagram. The introduction module contained an introduction to simulation lecture in years 2 through 4 that prepared the students for the simulation process and contained rudimentary information on the simulation process, methodology, CRM, TeamSTEPPS, teamwork, leadership, legalities and the study IRB. In the last module (6 in year 1, 10 in year 2, and 12 in years 3 and 4), exit interviews with the students were videotaped as part of the collected data. This information would later be transcribed and used for analysis as described in Chapter 6.

Figure 8. Diagram of years, modules, and simulations.



By the end of the study, the number of simulation dates or modules required each year expanded based on student needs and dwindling clinical site availability. In year 1 of the study, only six modules were used. By years 3 and 4, this number had expanded to 13, more than doubling the previous year. Table 4 shows a breakdown of the modules by year including total times each module was run in each year. A total of 171 modules were run in this study.

In viewing Table 4, it can be seen that in year 1, the total modules conducted were six even though the number of times they were conducted was the highest in the study. This was due to an extraordinarily high number of students coupled with experiments on the ideal number of students for a simulation experience. I report this in Chapter 4. In year 2, you will notice that the number of modules went to 11. In that year, I added an

introduction lecture and module that was different from the rest of the modules. It was clear to us that the students need to be acquainted with the simulation better, based on experience and feedback in year 1 from students and instructors. At the conclusion of year 2, there was an overwhelming response from students in the exit interviews to expand the modules once more. In the third and fourth years, the highest diversity and number of different modules occurred with a total of 13 modules. Year 4 also represented the lowest cohort of students in the program. For that reason, the number of times each module was run was the lowest in the study.

Table 4

*Total Simulation Modules by Year*

Modules	Year 1	Year 2	Year 3	Year 4	Totals
Intro		5	5	2	12
1	8	5	5	2	20
2	8	5	5	2	20
3	12	5	5	2	24
4	8	4	4	2	18
5	5	4	4	2	15
6	5	4	4	2	15
7		4	4	2	10
8		4	4	2	10
9		4	4	2	10
10		3	4	2	9
11			3	1	4
12			3	1	4
Total	46	47	54	24	171

Within the modules, a total of 32 simulations were created, as shown in Table 5. One simulation was repeated in year 2 (Adult Traumatic Amputation) at the request of the students so that they could immediately apply what was learned in the debrief. Interestingly enough, in years 3 and 4, none of the students were interested in repeating that simulation. They were more interested in using the time to experience other simulations. Table 5 shows a breakdown of the simulations along with the number of times that each was conducted over the 4-year study. Year 4 shows the least number of module runs due to the low cohort number; however, it also is the only year in which every scenario was run. This was due to increases in overall efficiency. A total of 394 simulations were conducted over this 4-year study.

Table 5

*Scenarios Conducted by Year*

#	Scenario Name	Year and Total				Total
		Alpha 1	Beta 2	3	4	
1	Adult COPD with Pneumonia	8	5	5	2	20
2	Adult Asthma	8	5	5	2	20
3	Adult COPD Decompensating	8	2	5	1	16
4	Adult COPD Decompensating (revisited)	0	2	3	1	6
5	Adult CHF Acute Attack	8	5	5	2	20
6	Adult Do Not Resuscitate	8	4	5	2	19
7	Adult Tuberculosis with Respiratory Distress	0	0	5	2	7
8	Adult Traumatic Amputation	0	4	3	1	8
9	Adult Traumatic Amputation Rerun	0	4	0	0	4
10	Adult BiPolar Manic	0	4	4	2	10

Table 5–Continued.

#	Scenario Name	Alpha				Beta				
		1	2	3	4	1	2	3	4	Total
11	Adult Depression/Suicide Attempt	0	4	4	2	10				
12	Adult Sick Person	0	4	0	6	10				
13	Adult Cardiac Arrest	0	4	4	2	10				
14	Adult Narcotic Overdose	0	0	5	2	7				
15	Adult Toxic Inhalation (Fire)	0	0	3	1	4				
16	Adolescent OverDose/Assault	0	0	0	2	2				
17	Pediatric Epiglottitis	8	5	4	2	19				
18	Pediatric Acute Asthma Attack	8	5	4	1	18				
19	Pediatric Drowning/Full Arrest	8	5	4	2	19				
20	Pediatric Febrile Seizures	8	5	4	2	19				
21	Pediatric Sick Person	0	0	0	1	1				
22	Pediatric Trauma (Shooting)	0	3	3	1	7				
23	Pediatric Trauma (Refusal of Transport)	0	5	4	2	11				
24	Obstetric Normal Cephalic Delivery	8	4	4	2	18				
25	Obstetric Limb Presentation	8	4	4	2	18				
26	Obstetric PIH/Eclampsia	8	4	4	2	18				
27	Obstetric Breech Delivery	8	4	3	2	17				
28	Obstetric Placentae Previa/Rupture	8	4	3	2	17				
29	Obstetric Umbilical Cord Presentation	0	3	4	2	9				
30	Obstetric Trauma Induced Miscarriage	0	3	4	2	9				
31	Geriatric Patient w/Hip Fracture	0	4	4	2	10				
32	Geriatric Syncope Episodes	0	4	4	2	10				
33	Geriatric Trauma Multisystems	0	0	0	1	1				
	Totals	112	109	113	60	394				

All briefings, simulations, and debriefings were audio-visually recorded throughout the 4 years of the study. Year 1 was the most difficult year to record since each environmental simulator had its own recorder. A simulation would therefore exist on three recorders: one for the scene, one for the ambulance transfer, and one at the

emergency room. As discussed in the context section, there was a lot of “down time” while waiting for the technology from one environmental simulator to seize control of the manikin from another environmental simulator. This was rectified in years 2-4 by adding a video switch and a centralized control room. Because of this problem, times on recordings had to be estimated in year 1, based on the splice times on the recorders adding the “missing” time. It is a best-time estimate based on those electronic recorders. For those reasons, Table 6 summarizes the years 2 to 4 data in the totals.

The averages of the briefings, simulations, debriefing, and total simulation time can be found both in Table 6 and as a graphical representation in Figure 9. Year 1 was an anomaly compared to years 2-4 for simulation time. This was the result of additional “down” time between environmental simulators when students moved from one to the other. It was remedied in years 2-4 with the addition of a video-switch and centralized control room. When year 1 was removed from the simulations, the average simulation time was relatively consistent and averaged just under 30 minutes (0:29:47). Likewise, the debriefing time averaged just over 43 minutes (0:43:12) per scenario. Year 1 was slightly longer due to problems discussing delays and issues that occurred between simulators.

During modules, there was one briefing presented at the beginning of the module, followed by two to three simulations, each with a debrief. Overall, briefing times increased over the 4-year span, as seen in Figure 9. In year 1, I realized that I needed to decrease the overall time for a simulation. In year 2, one of our actions was to decrease many of the briefing slides and, thus, reduce time. I actually learned that I had taken out



Table 6

*Total Time in Simulation*

	Time	Average Briefing Time per Module	Average Simulation Time per Sim	Average Debriefing Time per Debriefing	Total Sim Time (sim+debrief only)
Year a	Estimated Average per Scenario	0:18:03	0:59:30	0:51:12	1:50:42
	Estimated Total Scenario		53:33:00	46:04:48	99:37:48
Year 2	Average per Scenario	0:12:29	0:29:01	0:40:30	1:09:31
	Total Scenario		52:13:40	72:53:34	125:07:14
Year 3	Average per Scenario	0:18:10	0:31:07	0:46:12	1:17:18
	Total Scenario		59:06:27	87:46:00	146:52:27
Year 4	Average per Scenario	0:23:31	0:29:14	0:42:54	1:12:08
	Total Scenario		29:13:54	42:54:00	72:07:54
Total	Average per Scenario (Years 2-4)	0:18:03	0:29:47	0:43:12	1:12:59
	Total Scenario (Years 2-4)		140:34:01	203:33:34	344:07:35
Total Module Time in Debriefing (Years 1-4)					51:46:37
Total Simulation Time (Years 1-4 all Sims + Debriefs)					443:45:23
Total Video Data Time					495:32:00

*Note.* Times are presented in hours:minutes:seconds. Year a is an estimate based on averages.

information that was needed for the students. Slowly, over the next 2 years, I added back some of the very important cut items that were vital to the simulation learning. Briefing time was actually longest near the end of the study; however, some of the decreases in debriefing and simulation time were due to this action.

Besides, briefing time changes, Figure 9 shows how the overall sim time decreases over the 4 years of this study. The figure shows that the simulation time and debriefing time in years 2 through 4 became relatively stable after a significant reduction from year 1. This was due to getting the context correct and decreasing the “down” time between simulations and within simulations. Year 4 was one of the most efficient simulation years in the study, as shown in Figure 9.

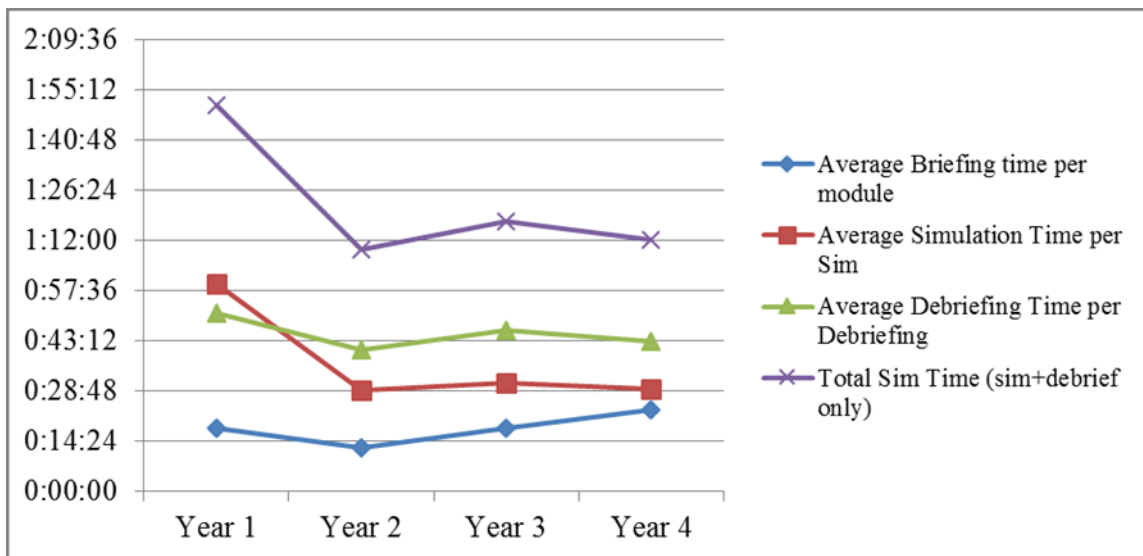


Figure 9. Graph of briefing, simulation, debriefing, and total simulation time.

Over the 4-year study, the number of individual hours the students participated in the simulation increased. This can be seen in Table 7. In the first year, a student would participate in 30 hours of clinical simulation time. By the third and fourth years, this had been increased to 65 hours to cover additional competencies unavailable in the clinical setting. Table 7 shows the scheduled hours per module spent by each student; however,

this time does not include the time spent checking the ambulance prior to their simulation or times when a module ran late in an individual group.

Table 7

*Total Individual Student Hours by Year*

Modules	Year 1	Year 2	Year 3	Year 4
Intro		5	5	5
1	5	5	5	5
2	5	5	5	5
3	5	5	5	5
4	5	5	5	5
5	5	5	5	5
6	5	5	5	5
7		5	5	5
8		5	5	5
9		5	5	5
10		5	5	5
11			5	5
12			5	5
Total	30	55	65	65

**Student Participant Demographics**

The Clinical Simulation Pre-Course Surveys were distributed to years 3 and 4 cohorts. Overall, 61.3% of the participants were male, with a slightly higher female population in the third year (43.5%) than in year 4 (25%). All were Caucasian. The average age of students in year 3 was 26.3 while for year 4 it was 31.63.

Regarding previous experience, the majority of students (year 3 = 74%, year 4 = 88%) were licensed at the Basic EMT level. The remainder were trained at the Basic

EMT level pending licensing (year 3 = 17%) with two exceptions: three students were trained or licensed at the intermediate EMT level and one student had partially completed a previous paramedic program. Table 8 shows a summary of the demographic and experience results.

Within the Pre-Simulation Survey for years 3 and 4, students' views towards high-fidelity healthcare simulation and leadership were examined. Table 9 shows a summary of this part of the survey. The majority of the students had limited, to no experience, with high-fidelity healthcare simulation (55% none, 39% limited to one class). Likewise, it was no surprise to find that there was little knowledge of high-fidelity healthcare simulation by the majority of students (68% overall). In one case, the student had experience with high-fidelity simulation in the military within ship simulators. A few students (17%) in year 3 had participated in a short pediatric study involving pre-hospital providers using simulation. The majority expected that high-fidelity healthcare simulation would increase their medical understanding (61% overall).

In previous studies, some concerns had been raised regarding the feelings of practitioners at being recorded. Within this survey, an overwhelming majority (77%) felt that it didn't bother them (29%) or actually liked it (48%). No one expressed a desire not to be recorded.

Table 8

*Student Demographics*

Variables	Year 3		Year 4		Overall
	Frequency	%	Frequency	%	%
<u>Gender</u>					
Male	13.0	57	6.0	75	61
Female	10.0	44	2.0	25	39
<u>Age</u>					
20-22	5.0	22	1.0	13	19
23-25	10.0	43	3.0	38	42
26-30	5.0	22	0.0	0	16
30-39	1.0	4	1.0	13	6
40-49	1.0	4	3.0	38	13
50+	1.0	4	0.0	0	3
Average Age	26.3	-	31.6	-	-
Mode	23.0	-	23.4	-	-
<u>Ethnicity</u>					
Caucasian	23.0	100	8.0	100	100
<u>EMS Experience</u>					
Trained Basic EMT	4.0	17	0.0	0	13
Licensed Basic EMT	17.0	71	7.0	88	77
Trained/Licensed					
Intermediate	2.0	8	1.0	13	10
Trained Paramedic	1.0	4	0.0	0	3
<u>Other Medical Experience</u>					
None	14.0	61	4.0	50	58
Fire Science/Fire					
Department	2.0	9	2.0	25	13
Military Medic	3.0	13	0.0	0	10
Other	4.0	17	2.0	25	19
<u>Field Experience</u>					
0 (none)	11.0	48	2.0	25	42
Less than 2 years	5.0	22	1.0	13	19
2-5 years	2.0	9	3.0	38	16
5-10 years	5.0	22	0.0	0	16
Over 10 years	0.0	0	2.0	25	6
Average Experience	2.0	-	5.6	-	-
Mode	0.0	-	0.0	-	-
Median	0.8	-	5.7	-	-

One of my concerns in this study was the willingness of students to share thoughts and feelings within the debriefs. An overwhelming majority (94%) expressed that they were comfortable with sharing thoughts and feelings during the debriefings.

One of the premises in this study is that leadership can be learned by students. Within the survey, I asked the students about their beliefs regarding whether they believed leadership could be learned or it was an inherited trait. The majority (68% overall) believed it was both inherited and learned. None expressed the belief it was solely inherited. Roughly a third (32%) expressed that it was solely learned through experiences and mistakes. This would suggest that the students believe they can improve their leadership capabilities through these simulation experiences.

The comments of these surveys provided some interesting insights into what the students expected in simulation. Some expressed some nervousness about the process. One student wrote, "I am nervous but this is the time and place to be that way. I hope that I can overcome these feeling and be able to prepare myself for the 'Real world experiences.' I hope that I can do the task that I have learned and put it to work." Another wrote, "I am not used to being able to visualize my patients and make a determination on the patient's condition. I also get nervous about sims." Still another stated, "My guts tell me I will 'mess up' a lot as I have trouble treating mannequins as opposed to human patients." There was a definite fear of making mistakes that some students entered the simulations with.

Other students expressed excitement about being challenged. Stated one student, "It [simulation] sounds like a challenge and I want to see what it's all about. I believe that simulations, combined with applying skills learned in the lab settings, will aid in learning

Table 9

*Previous Simulation Experience and Opinions*

Variables	Year 3		Year 4		Overall
	Frequency	%	Frequency	%	%
<b>High Fidelity Simulation Experience</b>					
None	11	48	6	75	55
Limited use in class	10	43	2	25	39
Use in multiple previous classes	1	4	0	0	3
A lot of experiences with HFMS	1	4	0	0	3
<b>Knowledge of High-Fidelity Simulation</b>					
None	14	61	7	88	68
Read or seen it performed	5	22	1	13	19
Experienced as a participant	4	17	0	0	13
<b>Expectation of High-Fidelity Simulation</b>					
None	2	9	1	13	10
Increased medical understanding	17	74	2	25	61
Identify what is not known	5	22	2	25	23
Test of abilities	6	26	3	38	29
<b>Feelings on being recorded</b>					
Don't want to be recorded	0	0	0	0	0
Uncomfortable but understand it's to learn	5	22	1	13	19
It doesn't bother them	6	26	3	38	29
Believe recording is great and like it	12	52	3	38	48
Not sure	0	0	1	13	3
<b>Willingness to share thoughts and feeling in debriefings</b>					
Don't like sharing personal thoughts and feelings	0	0	0	0	0
Uncomfortable but will if required	1	4	1	13	6
Comfortable with sharing thoughts and feelings	22	96	7	88	94
<b>Is simulation a good way to replace clinical experiences</b>					
No opinion	8	35	4	50	39
Same as live patient	1	4	1	13	6
Better than live patient	3	13	1	13	13
Not as good as live patient	5	22	1	13	19
Can only be used when we can't get live experience	7	30	1	13	26
<b>Belief regarding Leadership</b>					
Leadership is inherited trait—some good some not	0	0	0	0	0
Leadership is a learned trait learned through mistakes	6	26	4	50	32
Leadership is both inherited and learned	17	74	4	50	68
Leadership has nothing to do with EMS	0	0	0	0	0

how to treat patients accordingly.” A different student expressed, “I think it will be helpful and I’m excited to see what it is all about.” Still another student said, “I feel like it will be a challenge, and a great opportunity to identify weak spots and develop skills.” Lastly, one student wrote, “I’m hoping they [manikins] will improve my skills, after I get used to them. I’m looking forward to starting simulations, I think it will be a great experience and help me prepare for the real patient.” Many students expressed similar comments to the above, voicing excitement about this new method of learning.

Many of the comments expressed realization of the unique learning environment that they are about to partake in. One student stated, “I will learn a lot from simulation, and in simulation I may get some experience that I may not get in an Ambulance or hospital.” Still there were some comments that expressed no idea what to expect. One student stated, “I don’t know anything about them.” Another stated, “I have no idea what to expect from this but I’m willing to give it a try.”

In reviewing the comments regarding simulation, the themes that emerged were some nervousness about making mistakes, excitement about doing this process, vagueness about what to expect, and realization of the learning opportunity. All expressed a willingness to learn, and there were no negative comments about this process.

### **Competencies Achieved Through Simulation**

Competencies achieved by paramedic students in this study were tracked both in the simulation laboratory and outside of it using traditional clinical methods. To successfully complete each competency, a number of experiences are required. Table 10



shows the final number of required experiences in column 2. The subsequent columns show the results by study year using averages of the students in each category.

The number of competencies achieved varied by student; however, due to the deficits in clinical opportunities, the specific simulations targeted select competencies such as obstetrics and pediatrics. Table 11 shows competencies achieved in order of their overall required experiences. The percentages shown are an average of years 2-4 per

Table 10

*Summary of Total Competencies by Year*

Competency	Final Experiences Required	Year 1			Year 2			Year 3			Year 4			Total
		Competencies by Sim	Total Competencies	Percentage by Sim	Competencies by Sim	Total Competencies	Percentage by Sim	Competencies by Sim	Total Competencies	Percentage by Sim	Competencies by Sim	Total Competencies	Percentage by Sim	Overall Percent by Sim
Abdominal Assessment	20	1.1	20.8	5	5.4	22.5	24	4.2	25.3	17	3.3	21.8	15	15
Adult Assessment	50	2.0	58.0	3	10.0	96.9	10	14.1	92.1	15	9.5	86.7	11	10
Adult Dyspnea	20	0.8	22.8	3	4.6	27.6	17	7.3	27.1	27	4.7	25.8	18	16
Altered Mental Status	20	0.5	22.6	2	4.0	25.6	16	6.5	26.6	24	4.5	23.7	19	15
Chest Pain Assessment	30	0.3	28.6	1	0.9	23.2	4	0.7	27.9	3	1.7	27.5	6	3
Endotracheal Intubation	5	0.6	6.2	9	0.7	8.6	8	1.0	7.2	14	0.7	9.7	7	10
Geriatric Patient	30	0.2	40.0	0	1.9	45.4	4	1.9	43.6	4	2.2	42.3	5	4
Medication Administration	15	0.9	28.9	3	3.4	56.6	6	2.6	57.5	5	3.8	57.7	7	5
Obstetric Patient	10	2.8	9.6	29	5.6	11.4	49	6.8	12.5	54	6.5	12.7	51	46
Pediatric Dyspnea	8	2.4	7.9	30	3.6	6.5	56	5.3	8.6	61	4.7	10.0	47	48
Pediatric Assessment	30	3.6	26.3	14	5.9	21.7	27	6.8	28.4	24	7.3	26.3	28	23
Psychiatric Assessment	20	0.1	16.3	1	1.9	21.9	8	1.9	21.2	9	2.5	18.2	14	8
Team Leader	50	2.6	60.5	4	10.2	60.7	17	11.4	61.4	19	10.0	51.2	20	15
Trauma Patient	40	0.9	35.6	3	4.6	26.0	18	5.4	34.6	16	5.7	36.2	16	13
Unintubated Ventilation	20	2.6	15.5	17	3.9	13.5	29	5.5	11.1	50	4.8	16.3	30	31
Venous Access	30	0.6	39.0	1	2.8	67.4	4	2.4	61.4	4	3.5	53.0	7	4
Average		1.4	27.4	8	4.3	33.5	19	5.2	34.2	22	4.7	32.4	19	17

Table 11

*Ranking of Competencies Achieved Through Simulation*

Competency	Overall Percent
Pediatric Dyspnea	48.5
Obstetric Patient	46.1
Unintubated Ventilation	31.3
Pediatric Assessment	23.1
Adult Dyspnea	16.3
Abdominal Assessment	15.3
Altered Mental Status	15.3
Team Leader	14.8
Trauma Patient	13.0
Adult Assessment	10.0
Endotracheal Intubation	9.6
Psychiatric Assessment	7.9
Medication Administration	5.1
Venous Access	4.0
Geriatric Patient	3.5
Chest Pain Assessment	3.4

competency and taken from the data provided in Table 10. As designed, the scenarios addressed the pediatric and obstetric deficits.

Clinical simulation was more efficient in obtaining competencies than in the traditional clinical settings. In reviewing the competency experiences achieved in years 3 and 4, paramedic students used simulation to achieve 22% (1,174 experiences by 14 students) in year 3 and 17% (452 experiences by 6 students) in year 4. These experiences

were gained over approximately 65 hours of scheduled simulation time in the simulation laboratory. This works out to a ratio of 1.29 competency experiences per student per hour of simulation time. Using similar numbers for the traditional simulation (year 3—6,479 competency experiences/520 hours of traditional clinical time/14 students), the ratio was 0.89 competencies experiences/student/hour of clinical time. Year 4 worked out to a traditional simulation ratio of 0.85 competency experiences per traditional clinical hour per student. Table 12 shows a summary of these data.

Table 12

*Competency Experiences by Student Hour*

	Year 3	Year 4	Average
Total students	14	6	
<u>Total competency experiences</u>			
Simulation	1,174	452	
Traditional clinical	6,479	2,662	
Total in year	7,653	3,114	
<u>Total hours</u>			
Simulation	65	65	
Traditional clinical	520	520	
<u>Competency Experiences/Hour</u>			
Simulation	1.29	1.16	1.22
Traditional clinical	0.89	0.85	0.87

From Table 10 and the MDCH Paramedic Goals and Objectives, the final number of recommended experiences to achieve the 16 competencies is 398. Each student must have this minimal number of contacts in the 16 categories to achieve success. Multiplied against the ratios determined in Table 12, this equates to a minimum of 457 hours to

achieve them using only traditional clinical methods. If only simulation were used, it equates to a total of 326 hours or a savings of 131 hours. In this study, simulation was shown to be a more efficient method to achieve competencies compared to traditional clinical methods. The data are summarized in Table 13.

Table 13

*Calculation Time for Paramedic Completion of Competencies*

Setting	Experiences	Factor	Hours
Traditional clinical	398	0.88	452
Simulation	398	1.25	318
Difference			134

## CHAPTER 6

### FINDINGS: QUALITATIVE DATA

In Chapter 5, I discussed the quantitative data that were collected. Within Chapter 6, I discuss the qualitative data that were collected. I have heard qualitative researchers state that, at some point, the data spoke to them in their study. Within this study, that was certainly true. The greatest difficulty was to organize what was said so that the patterns could be seen. This was at times difficult since some of the concepts overlapped in the data, such as the use of video and facilitated debriefing or teamwork and leadership.

As an embedded researcher, patterns in the data quickly began to emerge starting in the first year. These patterns often caused me to search for deeper knowledge; thus producing greater amounts and different types of data. By the fourth year, the patterns were seen to repeat themselves, saturating the collected qualitative data. It is those data that are presented in this chapter.

Within this study, the qualitative data that were collected are represented in Table 2. In both collecting and reviewing these data, themes began to emerge. It makes more sense to present the themes and supporting data to those themes rather than represent it by a specific collected item, since this will allow the reader to more quickly see the relationships. For that reason, this chapter organizes the data by the theme and sub-themes collected, largely using the participants' words.

## A Student View of the Simulation Environment

Different learning styles require different environments for their use. Such is the case with high-fidelity simulation which requires a learning environment that is unique in that it closely mimics the real world. Students were asked about this environment and how it impacted learning. The following sections detail their responses.

### Realism

In year 1 of the Chapter 4 context, I described how it was difficult for some students to immerse themselves into simulation. I quickly realized that realism made it easier for students to overcome the “suspension of disbelief.” Because of this, throughout the study, I asked the students how realistic the stimulations seemed. One fourth-year student responded,

Scary, very realistic, more realistic than I thought they could have done, quite frankly. There were some scenarios where things were coming at us and I'm like, you know, and the mannequins in particular. I mean you're able to listen to breath sounds, take a blood pressure, run a 12 lead, and to really be able to assess a mannequin and get true vitals and truly be able to say muffled R-tones and there's absent breath sounds, tension pneumo [pneumothorax], you know, reactive pupils, and then they have extra piece of having Chet and Julie communicate as the mannequin, through the mannequin speak in response to your questions or agonal breathing or altered responses. That was—they were incredibly realistic, like scary sometimes. Like that peds sim [pediatric gunshot simulation], if you had GSW to the head, no exit wounds, this bleeding so it can get you—it can kind of get you pumped as you're going through it. Ugh, you're sweating and [arrgh sound as he looks up] and then you see yourself on camera later and you're like wow, I need to just breathe. So very realistic.

Another student stated, “When the engines worked properly, very realistic. Um, pupils being able to dilate, breathing on their own, finding a pulse and all that stuff that you wouldn't expect a mannequin would be able to do. It was very cool and realistic to me.” Still another stated, “Like it's as real as you get—can get besides doing a real call, I

mean having that real patient. I think it's the closest thing you'll ever get.” After the first simulation, a third-year student stated, “I was pleasantly surprised at the realism that was able to be obtained via use of the HAL mannequin.”

Some students compared it to their experiences working on the ambulance as a Basic EMT. Stated one student,

I mean, from being out and working the streets . . . and seeing how things are done, I mean, it's—it's about as close as we can get to real realism with the current technology. I mean unless technology gets better, it's not going to get any more realistic. I'd say it was realistic enough to where you're—when I was doing it, I didn't feel like I was playing with a doll. I felt like I was treating a person and I would just do it like I was really doing it because it just felt so real.

Students quickly realized that the scenarios were designed to mimic reality. A student stated, “Oh, I'd say [the scenarios were] 99 percent, pretty realistic. Well, the fact that we had somebody putting them together, or people putting them together that actually have played out in the field and done this.”

Part of the contribution to reality was the manikin's ability to physiologically respond to the treatments the students gave. Regarding this, a student stated, “I learned how a patient responds to the treatments that I gave them, I also learned how quickly the patient seems to respond to albuterol and when Atrovent is added, the response is even better.” In addition to the administration of medications, the manikins responded to skills performed. One student summed how the realism affected the simulation.

In here [simulations], it's like there's no direction. It's up to you to make the decisions . . .—it's part of the learning process. You're making decisions in the simulations based on knowledge you've learned through reading and instruction in the classroom labs. You're using the skills in the back of the ambulance and, um, you—and it gives you a sense of responsibility if you can let yourself get drawn into simulation, if you let yourself get drawn into it as though it were a real live call.

## Controlled Environment

Paramedic students appreciated the controlled environment that was represented in the simulation lab. Stated one student, “The fact that you actually get to use the actual teachings in a controlled environment versus using it on the street where anything can go wrong.” Another student stated,

It's a controlled environment, so you could—you feel a lot more—like you're using—you feel a lot more—uh, how do you phrase this? At once, you can redo it over and over again, versus one patient in real life. You have to get what's right.

Still another stated, "You have your ability to mess up or make bad calls without consequences.”

When students participate in clinical experiences in the field and hospital, they are required to produce a shift summary that lists each type of call that they experienced. As the researcher in this project, I reviewed these shift summaries. One of the things I was amazed at was the lack of uniformity in the clinical experiences that they had. Some students may experience multiple pediatric patients while others would experience none in the clinical setting. There was a randomness to it that was quite opposite of the controlled environment presented in the simulation lab. At the end of their experiences in the simulation lab, all students had experienced the same types of calls in this controlled environment.

## A Safe Place to Make Mistakes

To participate in the clinical setting, students are required to have malpractice insurance. This requirement occurred because mistakes or errors in their treatments can have significant consequences in the form of harm, injury, or death for the patients they



come in contact with. While safeguards are put into place, accidents do occur in the training process while experiencing clinicals.

Students appreciate the safety aspects of clinical simulation. One student stated,

You got to see how it [medical problem] worked [on a simulated patient] and if you screwed up, you got to see what would happen to a patient if you did. So it kind of allows you to go out and make your own mistakes and learn from them without having it negatively affect anyone.

Another stated, “It [simulation] was pretty close to the clinicals or the clinical experiences, just if we messed up, it wasn't as big of a deal. It didn't have a negative impact on somebody's life.” Still another stated, “It's a great learning experience to show us what it's like out in the streets. It's a safe place to make mistakes and learn from them. Also we can see our strengths and weaknesses.”

In the final interviews, one third-year student stated,

Like I said, because there's—it gave us an opportunity to use our skills and what we've learned in the classroom, apply it and if we messed up something really bad, you know, we weren't killing somebody. I mean we were, but we weren't.

I thought this was very interesting because, in actuality, no live human was ever harmed or killed in our lab, only the manikins. However, the student expressed transfer of feelings, giving the manikin a human level of quality. How real was that?

Many students described the simulation environment as a “sink or swim” environment. Stated one student,

I found it important because it gave me a chance to practice my skills in an area where you weren't getting feedback from your instructor. They kind of like just, you know, pushed you off the boat and said swim, and you have to see how you would do without killing the patient if you messed up. So that was the nice part.

Overall, the students described the simulation learning environment as a realistic one in which it was safe to make mistakes. They also stated an appreciation for the

autonomy it offered them in decision making while providing a controlled environment that protected them while they were learning. Instructors appreciated the control that environment gave towards building a uniform set of experiences for each student.

### **Students' Perception of Simulation-Based Competencies Achieved**

One concern that was voiced early in this study was whether or not the quality of the competencies achieved would be similar to or exceed that of experiencing them in real life. For that reason, students were asked to compare their competencies achieved in simulation against those achieved in simulation. Since they had achieved these competencies in both settings, it was believed that they would give an honest appraisal to how the experiences compared.

#### Quality of Simulation-Based Competencies

Regarding simulation competencies, all stated they felt the competencies were equivalent or even better in the simulation lab. One student stated,

I'm definitely more confident now than I would be had we not done the sim lab. You know especially the OB stuff. That's something I just didn't feel very comfortable doing in the first place. But, I mean now, I would say that in a real scene, I have an idea of what needs to be done, so—and, uh, a few of those calls, had we not done those in sim lab, I think that I'd be clueless on a real scene. Not as much as I would like. That might just be a part of my personality.

Another stated, "I'm a total rock star with the competencies that I've received. I think I've got these. Yes, very much so." Yet another stated, "The ones I've achieved through simulation I'm pretty confident about." Still another said, "Pretty damn confident." All of the students voiced confidence in the simulation-based competency experiences they achieved.

Some students voiced concerns about lacking some competencies that were provided in the simulation laboratory. For example, one student stated,

No way. Again, I mean I had, um—you know when I started adding up the hours . . . 150 per first, second semester 140, and then the 250 here in the summer . . . and I still haven't seen a single birth. I still haven't seen a single penetrating injury, whether that's a stab wound, a gunshot, you know, low loss, high loss, whatever the case may be in terms of like traumatic amputations and any of that. The number of—of diabetics that I've run on, I've lost count. The number of COPDers that I've run on, I think I've lost count. Um, you know, people who've had ground level falls—everybody in their brother keeps falling down walking across their living room, tripping on their little tutu and walking off to the—to the mailbox to pick up the mail. Um, so those types of thing, yeah. But when you look at the competencies and you start talking about obstetrics patients, talking about pediatric patients, you start talking about multisystem traumas, those have not occurred in my clinicals, and I don't believe at this point they would've. Um, and a couple of the more advanced opportunities that I've had, took place in the ER, which was great experience, but I was one of eight or ten people working on a particular patient, which is great for the patient, but it's not a particularly beneficial learning opportunity for me. You know, I'm not the lead. I'm not in a situation where I get to make decisions and—and try to synthesize like making a field diagnosis and treatment because that's not in the patient's best interest. You know it would be in my best interest. So again, without the clinical sims, there's no way I would've gotten these competencies.

Another student stated,

I got most of them [competencies] from being in a clinical situation, but there are some that you just don't see that often, like pediatrics, and or the peds difficulty breathing or like the OB. Unless you were given OB shifts, you can't really guarantee something like that.

Yet another stated, “Like the OB's and the peds [competencies], I'd definitely come up short if we weren't doing them in here [in the sim lab].” The use of the clinical simulations to achieve competencies in areas such as obstetrics and pediatrics allowed the students to achieve their overall competencies.

## Could Simulated Competencies Be More Effective Than Live?

Some of the students told us that they thought performing the clinical competencies in the simulation laboratory was actually more effective than within the clinical setting. One student stated, “I watched myself starting an IV and didn’t realize that I had contaminated the site until Julie pointed it out. Like, I didn’t think so, but the TV don’t lie.” As a debriefer, I was amazed at how often procedural mistakes or shortcuts were made. For example, during the starting of IV’s, I found at least a handful of students in each year who made their needle poke penetrating the vein only to find they hadn’t prepared their supplies to complete the procedure with tape and a saline lock or IV solution ready to be attached. That act in the field results in lost IV’s—something a paramedic tries to avoid.

In summary, both students and instructors felt the quality and consistency of competencies achieved in simulation were at least equivalent to those in the actual setting. Some advantages to simulation-based competencies included allowing students to achieve competencies that were in low number within their actual clinicals and potentially allowing them to receive better feedback in what they did right or wrong using recorded video. There were no comments from students or staff that indicated simulated competencies were less effective than those found in the clinical setting.

### **Simulation Comparison to Traditional Clinicals**

In the previous section, I ended with the question of whether or not simulated competencies could be more effective than in live simulations due to the ability of recordings and feedback to review performance by the students. From early in the study, there was a question of how effective the quality of simulated experiences could be

compared to actual live experiences. In the *Realism* section, I presented the students' feedback on how realistic the simulation environment was compared to the clinical setting. In this section, I go further by discussing the quality of simulated experiences from an educational perspective. What impact does the simulation environment bring to the education experience for paramedic students?

### Problem of Uniform Experiences

In Chapter 1, I described how one of the goals of the paramedic education is to prepare the student for practice as a licensed paramedic in the pre-hospital environment. As part of this goal, paramedic students are exposed to 500 hours of clinical experiences in various healthcare settings. This includes various units within the hospital and on the ambulance. The participation in these clinical experiences is generally done on a one-on-one basis; that is, these students work in a specific area of the hospital or on the ambulance, gaining their experiences as the sole student assigned to that area or patient on that day. Because of this, there is tremendous variety in what the individual student experiences; unfortunately, there is also a lack of uniformity as well.

Within the program that this study was performed on, similar to all programs across the nation, each time a student participates in a clinical experience they are required to provide a brief description of the patients whom they had contact with. This contact includes hands-on or direct observation. As a result, I have an evidence-based source of data to examine regarding the quality and consistency of the experiences the paramedic students are receiving.

In reviewing these clinical simulation folders, there is a very wide gap in the quality and consistency of experiences gained by paramedic students especially in some

lower occurrence type calls. For example, in obstetrics there were 80 (Y3) and 37 (Y4) hospital and ambulance clinical obstetrics contacts where hands-on competencies in obstetrics assessment were achieved. In simulation, during that same time frame, there were 39 (Y3) and 76 (Y4). When you look at the severity of the conditions, within the clinical setting only three in year 3 and one in year 4 would be considered a moderate to critical patient consisting of a preeclampsia patient and a breech that was delivered by cesarean section. The rest were either pregnant patients who were being seen for a non-obstetric problem or patients with a normal cephalic or cesarean delivery within the obstetrics department. What this means is that only four students in both years saw a moderate to severe obstetrics patient within their live clinical experiences within years 3 and 4 cohorts. The rest saw only routine conditions. There is a significant difference in the uniformity of the experiences that are seen especially at the moderate to critical level within some areas of the live clinical experiences, and there is no way to control exactly what is observed by students in these settings.

### Simulation-Based Clinical Experiences

One of the things I saw in this study was that scenarios could be designed to provide clinical experiences in simulation that were at least equivalent to those experiences found in the clinical setting. In the above obstetrics example, within this simulation lab, 83% of the obstetrics patients encountered in simulation were moderate to critical (83%) in nature, consisting of patients with a limb presentation, *eclampsia*, breech delivery, *placenta previa*, and prolapsed cord. While their exact role might vary slightly (team leader or team follower), every student was exposed to every simulated patient in this category.

As mentioned in the previous sections, some students believed the experiences were actually superior to the clinical setting because of the feedback and control. From an instructional standpoint, the use of simulation experience seems to provide uniform experiences for the students. When a student completes the program, using the above example, I know that they have had experiences with certain high-risk or complicated obstetrical emergencies in a practical hands-on setting. While I have used obstetrics as an example, this same situation can be found in other categories as well.

### Time Spent Versus Experiences Gained

In Chapter 5, I have presented the data that showed the competencies achieved in simulation took less time to achieve than in the traditional clinical setting. Regarding quality and reality of the experiences, in the previous sections I have shown that simulated experiences can be viewed by students and instructors as equivalent, depending on the context of the simulation. The quality issue is one that is more difficult to describe and fits more within this qualitative section. Within the live clinical experiences, a lot of the patients seen are of a routine nature. The ability of students to experience the life-threatening conditions, yet alone treat them, is not easily achieved; however, within the simulation environment, these experiences can be replicated, producing a more well-rounded education experience for the paramedic.

### Simulated Versus Live Clinical Experiences

You might be asking the question about now, “Why shouldn’t we replace all clinical experiences with simulation?” Our students pondered and commented about that question as well. Continuing with the obstetrics theme, a student stated,

In regard to obstetrics, the opportunity to be present for birthing experiences in the hospital setting was of value if you were willing to watch and learn from staff . . . which I was and I learned A LOT. I sincerely believe that if you model yourself after the staff in Labor & Delivery you will present yourself in a more professional manner and provide a better experience for your patient should a field delivery occur. Birth is one of the most natural occurrences and EMS staff should not be as nervous as we tend to be. Combined with the SIMs experience EMS students get a much better education regarding labor & delivery than we ever have in the past! This makes me feel much more confident about this particular area which has always been of my least favorite and I have actually found it to be a remarkable experience!

Most students echoed similar feelings about the use of simulations with live clinical experiences. Another student stated, “You see stuff—critical stuff—you don’t see in the clinicals. But, there you see other things like what happens when we drop off a patient. It’s like one helps the other. [It’s] cool.”

In summary, one of the problems that live clinical experiences present is the wide variance in the quality and consistency of what individual students experience. This becomes more difficult with the experiences that are less frequent in nature. During this study, simulated experiences provided more consistent experiences for students than were available using the traditional clinical setting. Many of these experiences were not available within the traditional clinical setting. While the simulated experiences are not seen as a complete replacement to live clinical simulations by either the students or instructors in this study, they are an important ally to providing a more holistic learning experience by paramedics.

### **Students’ View of Audiovisual Use**

In this study, a conscious choice was made to video record all simulations, briefings, and debriefings. By doing this, the simulations could have segments replayed for students to observe their behaviors. Previous studies have indicated a reluctance for



practitioners to be videotaped in simulation. For this reason, I asked the participants how they felt about being recorded both before and after the simulation experience. Before the experience, as stated in Chapter 5, the students overwhelmingly were open to being recorded. In this section, I present their views both during and at the end of their simulation experiences.

### A Different Viewpoint

One of the ways students describe the advantages of the recorded video is that it provides a different viewpoint for students to use when analyzing their actions. Examples of this can be found in the students' words:

When you get videotaped, you can go back and critique what you did. There's stuff that I found I do that maybe wasn't pointed out by Chet, but I saw it myself. So it was—Yeah, constructive criticism, being able to see what I did wrong, or, like I said—I mean I'm one of those people move back and forth a lot—I pace. I don't pace as much anymore.

In another example,

[I learned] . . . well through the audiovisual feedback especially. You can see what you did right. You can see what you did wrong. You can learn things about yourself, especially emotionally speaking, how you act on scene, how other people view you, as a leader or as a partner. You can determine where you fit in in team dynamics.

While these were two quotes from several dozen that discussed the secondary viewpoint, there was a unique comment from a student regarding this form of learning compared to standard clinical experiences;

[Simulation is] better than clinicals because you see mistakes that no one else noticed or no one would've pointed out to you, and you can watch them be played back and then learn from it through instructor-mediated feedback.

## The Big Picture

Students often describe the video as providing a “big picture” of the simulation that they didn’t see when they were engaged in it as participants. Stated one student, “[The Video Debriefing] lets you see the big picture of things that you don’t realize that happened due to tunnel vision.” Another student stated, “I heard \_\_\_\_\_ tell me the patient’s respiratory rate on the scene, but in the sim I never heard her say that. The debrief [video] showed it though . . . twice. I guess I’ll pay more attention next time to the MFR [Medical First Responder].” Students often see things in the video that they never noticed when on scene.

## We Don’t Know What We Don’t Know (Part 1)

Within the debriefings, I would start each debrief with the question of how students were feeling after the last simulation. I did this to allow them a moment to vent their joy, feelings or frustrations so that they were more receptive to learning. Often, they would express how they thought they did on the simulation. I was surprised how often they had misinterpreted their performance, either good or bad. I began to realize the lesson was that *the students really didn’t know what they didn’t know*. As the students would receive feedback in the debriefing and see themselves on video, they began to get a clearer picture of their actual performance. As I went through the student data, this same theme came out from many different students.

One student commented, “We sometimes don’t realize what we do on a scene, or do well on a scene. The video is good constructive criticism; I think that you can improve if you see yourself in action, and then you can improve from there.” Another stated, “The video help[ed] me with things I missed or could improve on. It also showed me things

that I did well.” After viewing themselves in a simulation without clear leadership, a student commented, “[I saw] a lot of the things we missed, like the five minutes that we all just ran around doing nothing.” A fourth-year student commented,

I was able to correlate classroom critique with seeing it via video so that I can make any necessary corrections. Seeing what you actually did via video feedback also helps you realize that it isn’t always “all bad” as students sometimes feel when learning new skills in a scenario setting.

### Video Builds Confidence

A surprising result was that a number of students in all years indicated that seeing themselves in electronic recordings built their confidence in their abilities as a paramedic. One fourth-year student stated, “[For] me personally, it [videotaping] was just my confidence level. I’ve always been pretty confident in my skills. I’m even more confident now because I can watch myself and see what I do and how I do it and then you can improve.” Another stated,

[The most important part of the simulation was] the feedback with the tape because when you think things don’t—aren’t feeling or looking as good as you want them to; they actually can be surprisingly more positive than you’re feeling about it.

### **Instructor-Facilitated Feedback**

In the previous section, I discussed the students’ perception on the use of video in simulation. For the purposes of this study, I have separated them since they are different concepts; however, participants more often tied the two together in their comments and discussions. This section looks more at the aspect of facilitated feedback, or the controlled feedback given by the instructor to the students. It should be understood that in the debriefing process the video and facilitated feedback often complement each other. In

this section, I will present both the student's viewpoint as well as the instructor's viewpoint.

### Facilitated Debriefing Produces Learning

From having done the simulations over the past 4 years, as a facilitator/debriefer, I realize that the bulk of the learning actually takes place in the debriefing. However there is a skill to handling a debriefing that takes time to master. It's fairly easy to find and point out mistakes to learners; however, doing it in a positive way that is not confrontational or needlessly distressing is more of a challenge. I realized in the first year that part of our job in refining this debriefing process was to create a positive learning environment that builds students up while letting them know their errors. If I could help them to see and find their own errors, it was even better since in those moments they were fully responsible for their learning and changing the pathways of their critical thinking.

In support of the concept that facilitated debriefing produces learning, one student stated, "Without instructor feedback, I would not have even realized the small areas that could be improved upon." Another stated, "He [Chet] improved it by explaining things I did well and things I could improve on." Still another commented,

The debrief is probably the most important part. I mean we noticed or I noticed mistakes made during the simulation, but it's the debrief where you catch a lot of things and will have a lot of things pointed out, and I think that has the biggest impact on the learning.

Still another stated,

The instructor-mediated feedback helps provide a visual so that you can better identify with the constructive criticism you may receive about your performance. If the visual portion wasn't there, students might not remember or "see" what things they are doing that they may not even be aware of.

There were many comments by students that are directed towards their belief that the debriefing was the most important part of the learning process. I will discuss parts of this in other sections as well; however, this underlying concept permeated this study from the first year on.

Nearly every debriefing I conducted produced learning—usually much greater than was achieved by the simulation alone. It was the rare exception that a group would perform a simulation, correctly diagnose, treat, and interact with the patient, not missing anything. While those simulations did occur, they were rare, numbering less than a dozen over the 4 years. More likely what was observed was a spectrum from totally missing the mark, to getting the patient alive to the hospital with a few minor mistakes.

Distractors were often used in simulations to see how the students handled them, since distractions in real-life calls are nearly always present. At times, these distractors result in students missing parts of their leadership plan or they disrupt their thinking process. The real question is whether or not they can recover from it, similar to in real-life calls. In one simulation, the television is blaring a movie on scene while students are called to respond to a patient who is unconscious. The TV is so loud that they can't effectively communicate to each other. Many team leaders don't turn it off and instead try to shout over the noise.

Students often commented on the learning they achieved from their dealing or not dealing with the distractions. One student stated, "I learned to not overlook obvious stuff such as shutting off loud equipment, I also learned how easy it is to get hung up on on-scene issues and spend a lot more time doing tasks than necessary." Another student stated,

I learned that it is much easier to concentrate on scene when all possible distractions are eliminated. I learned this via the television being on during my patient assessment which made it hard to hear what the patient was saying and in assessing vital signs.

When asked why they didn't just turn it off, "I didn't think of that" or "I don't know" are the most common answers students gave. They are totally unaware of how much that distraction impeded on their treatment. In yet another simulation, a child of the patient is constantly asking questions and interrupting the treatment of the mother who is in labor. There are adequate numbers of team members (5) so that they could easily assign one of them to the child to control this distraction—however, the most common response is that they allow the child to continue interrupting the scene. Once again, when asked, the team leaders didn't know to do something here. There were many other examples of this in the study—but the learning from this didn't occur until the debrief.

### We Don't Know What We Don't Know (Part 2)

In the last video-based section, I discussed how the video helped show some of these errors; however, video alone does not provide students with awareness of their mistakes. Within the simulations, often students felt they had done a great job when, in fact, they had totally missed the diagnosis and actually done procedures that were harmful to the patient's outcome. While I speak more of this in the errors section, here are a few brief examples of the types of mistakes they made where they were totally unaware they caused the problem. These weren't known to the student until the debrief—presented by the facilitator/debriefer.

In one of the COPD scenarios, the patient who had an underlying chronic lung problem (COPD) was having difficulty breathing due to an acquired cold, stress from exercise, and overtaxed accessory breathing muscles for the past 2 days. As part of the

correct management of this patient, students should apply a continuous positive airway pressure device to the patient along with a nebulized medication called albuterol. This simulation was one of the first the students did in the lab. Within the scenario, instead of albuterol—which dilates the bronchi and allows for better breathing, several groups gave adenosine—a drug that chemically stops the heart like a defibrillator and would not be indicated for use in this patient. What they saw happen in the scenario as a result was the heart stopping, as it should have, followed by a restarting about 6 to 8 seconds later. One team leader, in their zeal, recognized the heart had stopped and that they were pulseless so they ordered team members to immediately start CPR—thus working the call as a full cardiac arrest. When the heart rate was recognized as returning (they stopped compressions to check), they felt they had saved the patient—as they proclaimed triumphantly in the debriefing. It was only in the debriefing that they became aware that they actually caused the arrest of the heart and it would have self-corrected had they waited an additional few seconds before starting CPR. Students often don't know what they don't know.

In another scenario, in a spontaneous abortion at 24 weeks, the student began working the dead fetus as a full arrest. Given the size and known gestational age, there was no chance for this fetus to survive; however, the student didn't know this. In the debrief, they thought they had done everything right. Unfortunately, in the focus to treat the baby, little treatment was given to the mother who was in need of additional therapy.

In yet another scenario, the patient simply had the flu. The purpose of this scenario was to see the students correctly manage a very routine call; however, it often turned into the management of a patient having a heart attack, ectopic pregnancy,

bradycardia (though the heart rate was 70), hypotensive patient (though the B/P was 116/60), and more. In the debriefing, students were often surprised to find out that the patient's only problems were mild dehydration from the vomiting, diarrhea, and poor fluid intake over the past 36 hours.

Not all events are as dramatic as those listed above. During one scenario, the team leader ordered a partner to give the patient oxygen via a non-rebreather mask. I asked why they did this during the debriefing. They answered, "Because that's we always do on scene." I further asked, "Why?" She didn't have an answer. The reality was that her patient was short of breath and cyanotic (turning blue) from lack of oxygen. While she did the right therapy, she didn't know why it was the right thing to do. In debriefing, asking the questions why something was done, even when it's the correct medical treatment to do, can often reveal gaps in knowledge or understanding that need attention.

In a drug overdose scenario, the patients are confronted with a patient who has overdosed on a narcotic, causing severe respiratory depression. In this scenario, the patient was discovered breathing at six breaths per minute—a rate that is inadequate. Many crews were witnessed in the scenario applying a non-rebreather oxygen mask (100%) only to find that the patient's cyanosis did not improve. They were totally unaware that a rate problem existed until either late in the scenario or they later corrected the problem with Narcan, a drug that reverses the effects of a narcotic. Until it was discussed in the debrief, they didn't know they made the mistake—in fact often they felt they had done the right thing by giving the Narcan without additional ventilator support. From an instructional standpoint, it is very clear that facilitated debriefing helps to correct students when they don't know what they don't know. One student stated it best, "I did



not learn any of this until we did the debriefing; didn't realize that I was doing these things until the debriefing.”

### Tunnel Vision

Tunnel vision is related to situational awareness. I will discuss more of this in the Leadership section; however, students describe this process as very stealthy or inconspicuous until you find yourself trapped by it. Within the debriefing process, students often recognize it after the fact. Stated one student, “There's a lot of stuff you see that you don't realize happened until you watch it. . . . There's certain things, when you're actually doing it, that you don't even realize you're either doing or not doing. He [Facilitator/Debriefing] really points out like if you're getting tunnel vision when you're involved in it. Like if you take the lead scenario, it so much puts you into a tunnel vision compared to just being somebody else. You see the bigger picture when you get in the control room and you view the whole thing and you're taken away from the stress and you get to see the whole picture.” Tunnel vision is a problem described by approximately a third of the students in simulations at one time or another.

I try to teach communications between our students and other healthcare practitioners. As part of this, I divide them into two teams within a simulation. One is the first team in, the medical first responders (MFRs), and the other is the paramedic ambulance crew. I watch for the report from the MFR team leader to the paramedic team leader when they get to the scene. It is amazing how often a report is given that accurately describes the patient's condition along with important findings only to find the team leader developing tunnel vision and not hearing a thing despite standing five feet from them. When asked during the debrief what they were hearing, they often stated that

they were watching the patient or elements in the scene rather than hearing what was reported. Tunnel vision is an element that can be dealt with only by having awareness of it and then taking actions, such as focusing attention on the team leader report, rather than elsewhere. Students are first made aware of this through the debriefing.

### Other Important Skills and Knowledge

I will address other important skills and knowledge base that are learned in other sections such as leadership, what students say caused learning, and more; however, the actual awareness and subsequent learning that occurred happened due to facilitated debriefing. This was the process of helping them see what they didn't see as a participant. It helped them to know what they didn't know they needed to know. Facilitated debriefing is a major component of this learning process using simulation.

### **Learned Leadership**

In the previous pre-simulation survey, leadership was a skill that all students who participated in this study believed was either partially learned or completely learned through experiences. Within this section, I will present the student- and researcher-based data collected in the simulations and debriefings regarding what was learned by the students about leadership using simulation. Leadership involves many sub-tasks or skills to be successful. For that reason, I have divided this section into subsections that represent these areas of leadership covered by the simulations.

### The Leadership Experience

Very quickly, the students realize that they will be required to be a leader in the simulation lab. At the beginning of each module, students cast a single die to determine

who will be the team leader and at what level within each of the simulations for the day. The instructor reserves the right to add a 6 to any role if the particular student has not had equal experiences at leadership during previous modules. The outcome of this process is that each student is forced to take a leadership role.

A lot of the leadership is learned through experience in the simulations. One student remarked about his leadership experiences, “Because of the experience, I think, it thrust me more into the world of EMS, especially like leadership type. Learning how to take control and how to delegate. At first it actually made me really nervous, and then towards the end, it gave me confidence.” The combination of forced leadership, facilitated debriefing, and audiovisual feedback was instrumental in teaching the skills of leadership. Another student stated, “The greatest benefit is probably just the hands-on, being able to take lead and get used to critical thinking skills.”

This experience in leadership was shown to be appreciated by students long after they had left the sim lab. In their exit interview, one student remarked,

Here [in the sim lab], we learned how to lead before we did it in our Internship. The video showed me stuff I didn't see as a team leader. Frankly, I wouldn't have believed some of it if I didn't see it with my own eyes the second time. I don't know anywhere else that is doing this.

Yet another fourth-year student stated in an email to me 6 months after completing her paramedic training,

I have been involved with four saves since I received my medic. Two out of the four went or will be going home. . . . I've been in charge of 2 of those cardiac arrests. The one was a complete save. I believe he will be going home soon. . . . The sim lab has a lot to do with how I run my calls and how I can keep a level head. Without that, I don't think I would have the success that I've had since becoming a medic.

The experience of leadership is one that is had and learned within the simulation experiences. I have a number of these anecdotal emails and personal comments from students who have applied their learned leadership in their profession as a paramedic.

### Responsibility

One of the first learned lessons of leadership that students are exposed to is that of responsibility for the team. Stated one student, “As team leader I am ultimately responsible how the call goes.” Yet another stated,

[I learned] by being forced to think, sitting there with no book and no instructors saying what do I do, and knowing that in the end, this is how I'm going to perform in the field, so I'd better get it now or I'm going to end up hurting somebody else in real life.

Responsibility is a key trait of leadership and within the debriefings, it was the leader who was held responsible for the actions of the teams. At the beginning of many of the debriefs, the leader would often step up and take responsibility for major errors that occurred under their watch in the last simulation. It was clear that responsibility was a theme of leadership.

### Learning Teamwork

It is impossible to lead a team without understanding the process of teamwork, and each student will one day be a member and likely leader of a medical team. There were many comments about learning teamwork by students and staff. Students describe learned teamwork experiences different ways. One student stated, “[I learned] how to work as a team and ask others for information that may help treat PT [the patient].” Another stated,

I learned that we have all come a long way since the first SIM experience and we work very well as a team. [Referring to their specific simulation] I would

also have selected a closer receiving hospital once I realized the situation at hand.

Yet another stated, “I learned tips on how to handle the situation better. How to work better with a partner. How to become a better leader. How to handle different events that happen.”

Students learn to rely on and understand each other as part of the teamwork experience. Stated one student, “It [simulations] kind of helped in chemistry and interaction with the other—other students. I think it helped us get—well, it helped us understand each other sort of better.” Another voiced his appreciation of team members being present when short-staffed on a call,

I learned that running as a two-man crew with no first responders can sometimes be difficult. I learned this because one of our partners called in sick so we had to run as a two-man crew and the extra hands on scene are always helpful.

Yet another in their exit interview stated,

I feel that our team has become a very productive, cohesive unit for the most part. When we are focused and calm we are able to accomplish the task at hand. We are like-minded individuals who have adapted ourselves to each other and by doing so can feed off each other in a positive way. We have learned to trust one another and utilize each person’s strong points to provide the best outcome for our patients at our level.

Within the debriefings, students would often compliment each other when they saw a well-done action within the simulation video. Over time, my fellow facilitator and I would see changes in their teamwork characteristics: They developed a form of trust and group gestalt as they worked through simulations over the 13 modules. In addition, they accomplished more things with less time. All of this related to working better together as a team.

## Command and Control

For a leader to lead, they must have followers who are willing to follow. Within these simulations, getting some individuals to learn the process of being a follower was challenging. Many insisted on taking charge from an assigned leader. If the assigned leader did not defend their leadership position, it often resulted in their subverting their leadership role—something they would later regret when watching themselves on video in the debrief. Supporting this concept, one student stated, “What I learned was that I need to keep my partners from freelancing when I am the lead. I need to keep better control of my scene.” Another student wrote,

I learned that I get very annoyed by having my team mate run over the top of me when I am supposed to be in a team leader role, to the point of leaving me behind and inadvertently blocking my entrance to the room with a cot because they have rammed in without thinking. Instead of focusing on patient care I have to regain control over my crew and then get myself back on track. I feel I need to learn not to let it bother me to the point of getting stressed and flustered. I learned this by experiencing it.

Through simulations, students quickly realized that they needed to take control if they were to be a successful team leader. For some with less dominant personalities, this was a big challenge.

Along the same lines, they also learned that they had to control the scene as well. When confronted with five students in the back of an ambulance, a student wrote, “I need to kick people out of my ambulance to make more room.” Leaders must manage the scene, which often means asking some responders to stay while asking others to leave. Stated another student, “The ambulance isn’t big enough for five people! . . . Three was a challenge.” Still another stated in a debriefing, “We had too many people on scene stumbling over each other. It was frustrating to lead.” A student frustrated with others’

actions in a simulation stated, “The call will go a lot smoother if people stick to their part.” Maintaining control of a scene is a lesson learned by doing it.

### Situational Awareness (Perceptual Awareness)

For a leader to make good decisions, they need to be aware of the situation around them. This is termed situational awareness or perceptual awareness. Within the simulations, conditions are constantly changing as new information is gathered. Students often commented on the changes in situational awareness. Stated one student,

I learned that there are never two calls alike, and that in a moment’s notice something can change. I learned this because we ran a call on a pregnant woman and we thought it was going to be similar to other calls that we’ve been on before judging by the dispatch info, but it wasn’t.

Another student stated, “It is important to get a clear picture of what actually happened. I heard what my partner told me but the patient looked different than what my partner told me.”

Students quickly learn that they need to monitor a situation for changes. Perhaps one student summed it up best about their feelings regarding participating in simulations, “Never to assume that Mr. D won’t throw you a curve ball.” Situational awareness is important.

As part of situational awareness, team leaders were exposed to situations where they developed tunnel vision. One student stated, “I learned not to get tunnel vision, or go off what you are dispatched and make sure that you evaluate your patient, learn to delegate instead of doing things yourself.” These were some strategies that they had learned to avoid tunnel vision. Situational awareness includes awareness of and coping strategies to avoid tunnel vision.

Time management was an important part of perceptual awareness. In a study by Jurkovich, Campbell, Padrta, and Luterman (1987), paramedics' perception of time was incorrect 20% of the time. Within this study with student paramedics, it was likely higher. Students were often amazed at how long their on-scene time was. Stated one student, "I learned how the perception of time was different for people depending on which position they were in." Yet another, "That we took way way too long on-scene, we needed better time management, although it felt like it was only a few minutes, it was really more than 20 minutes." Still another, "It is hard to keep track of time when there is a lot going on." Students often commented at how difficult their perception of time was.

During the scenarios, students would often run out of time in the back of the ambulance on the way to the hospital. This resulted in many failing to give a HERN (radio system used by EMS providers) report to the emergency room prior to their arrival or giving that report as they pulled into the ER entrance; leaving little or no time for the ER to prepare for their patient. They were so busy doing tasks and procedures, they simply overestimated the amount of time they actually had. Likewise, one of the scenarios they responded to was a traumatic amputation where on-scene time should be kept to a minimum. In year 2, the students were so upset with their long scene times (40+ minutes), they requested to rerun the scenario—which I did. None initially believed the length until they saw the video. Perception of time is important for paramedics to understand.

#### Sustained Inattention Blindness

Within our study, during year 1, I noticed that students in a leadership role would often overlook or not see a major change in the situation around them, whether it be with



the patient or the environment around them. They would often be so focused on a task or event, they totally missed what had changed. This process repeated itself over and over in the simulations. Unfortunately it frequently had bad outcomes for the patient or crew.

In the narcotic overdose simulation, the patient was found by EMS teams unconscious and cyanotic on their bed. The patient's pulse oximetry readings (measurement of oxygen in his blood) of 86%. It should be above 95%—why isn't it? The team leader had just attached the monitor and was trying to figure out why this patient was cyanotic and unconscious despite the fact he has been placed on a non-rebreather mask at 100%. He even announces to the group, "Any ideas why he's still blue?" Another student, who is at his head assessing his pupils, yells, "Gorilla! He's breathing kinda slow." The team leader asks what the respirations are. "Eight" is the response. "\_\_\_\_\_, let's switch to a BVM." Another student is undressing the patient as part of their secondary survey. You hear, "Second gorilla!" They have just found a second narcotic patch self-administered by the patient. Before, the sim will end, they will find one more. The team leader was so focused on the cause for the cyanosis that despite looking at the patient, who was very obviously breathing at six breaths per minute, he never saw it. It wasn't until another team member noticed it, that the first awareness was present for the entire group. Soon after, they found the gorilla's companion.

While attending a leadership conference, I became exposed to the research by Chabris and Simons (2010) on sustained inattention blindness which was published in their book, *The Invisible Gorilla*. Quickly there was a realization that this was what was occurring to our students when they didn't see changes. They were experiencing sustained inattention blindness, though they were unaware of it at the time. When I

presented this work to our second group of students following a number of simulations, they too recognized the pattern and the fact that it was the same thing they had lived—except without the correct name. From that point on, a phrase of *Gorilla* or *Red Flag* was used when a team member saw something that the rest of the group had not. It became a defense strategy to aid team leaders in avoiding this trap.

### Planning

Leadership usually requires a plan to be successful. In watching the simulations, it is all too common for novice leaders to enter a scene without a plan, only to quickly see it descend into chaos and misguided direction. One student stated in a debriefing when asked what their plan was, “I guess I didn’t have one.” When the same question was asked to another team leader in a different scenario, they stated, “I was planning on winging it.” I asked him how that worked out? He stated, “Not so good.” In this study, developing a plan seems to be a greater problem for students with little pre-hospital experience than those who had practiced in the pre-hospital setting.

The use of protocols and other documents can help them with these actions. A student wrote, “Calls that you don’t run you should visit protocols, and update yourself with materials such as reading to keep brushed up on the skills.” During the debriefings, the treatment protocols that should have been used were often displayed on the screen. This aided students in developing future plans.

Flexibility in the plan is also important. The unexpected nature of the simulations was an element that the students appreciated since it mimicked real life. A student wrote, “In the simulation I learned that not everything is going to go as planned and that you need to go with the flow and adjust to the unscheduled changes.” When students

encountered a simulation where the conditions didn't allow them to implement their original plan, frustration often occurred. Out of this comes learning. Stated one student, "I learned that even if you think you're ready for a call, nothing ever goes as planned. I learned this because we thought we knew where all of the equipment was and during the call had no clue." Yet another stated about their learning, "Calls can be different from dispatch info." Finally, one student learned to look for additional clues when their initial diagnosis didn't fit the patient. They wrote, "I learned when it was necessary to switch the focus toward my patients to go down another road of treatment for the best outcome."

A lot of individual lessons are also learned that impact future planning. While I will share a few here, be aware that there are a substantial number of these in the students' writings that deal with specific treatments and learned items. One student stated, "I learned to remember to use proper BSI [Body Substance Isolation] precautions." This was in response to being exposed to tuberculosis from a TB-infected coughing patient. The student and their team were not wearing masks throughout the whole call. Another stated, "I learned different ways to look for actions to take when dealing with the cases we were presented with." This was in regard to treating the pediatric febrile seizure and adult sick person scenario. Another student stated, "I learned that there is more to a refusal than just signing a paper. I learned this by running a call when a refusal was needed."

### Dealing With Stress

Students discussed and commented on their learning how to deal with stress during simulations. One student wrote, "I learned how to handle different things that get thrown at you when you're under stress." Still another stated, "[I learned] how to remain

calm while dealing with an [cardiac] arrest in the field.” Another student commented in their reflection log,

I learned tips on how to handle the situation better. How to become a better leader. It showed me things I did well and things I need to work on. It showed me how to keep my composure while I encounter a stressful situation.

Many students discussed what causes the stress and methods for dealing with it that they use. For example, one student wrote,

I learned that I need to slow down my thought processes. Refrain from getting right into the “nitty gritty” and think about the etiology of my patient’s problem and what the best treatment plan would be for them. I think that I get my cranial “processor” going too fast I need to slow it down a bit . . . think very carefully about what I am seeing and act on it. I know there are many times when I know exactly what is going on because of experience and I for whatever reason I take a course that is not necessary because I second-guess myself for fear of failure.

EMS responds to stressful situations and therefore leaders on scene must learn to deal with the stress as an element. Within the simulations, it was clear that students felt stressed by the scenarios and learned to deal with it throughout the modules.

### Communication

One of the most important aspects of leadership is the ability to communicate. For paramedics, this occurs at multiple levels using multiple different technologies. Within the debriefing, a lot of time is spent helping students notice their verbal and non-verbal communications with the patient, team, and others. One student expressed in their exit interview, “I didn’t realize how important communication was until I did it [in the simulations].”

Within the introduction to simulation lecture, students are exposed to Goleman’s (1995, 1998, 2011) Emotional Intelligence model and its impact on communications and leadership. While students are presented with the concepts of body language,

terminology, and other communications that impact how they are perceived, they don't fully understand it until they see themselves in practice via the video. These all impact the quality of the patient-provider relationship that needs to be established in a short time.

One benefit of video recording is that students can see and hear exactly what they sound and look like. Within the debriefings, many students immediately pick up on unconscious habits they have or body positioning they weren't aware of. A common mistake made is standing over the patient in an intimidating manner, which resulted in diminishing the patient-provider relationship. A student commented from an early simulation, "[I learned to] . . . treat the manikins like they are human, and get down to the patient's level." Another stated, "I saw how I was standing over the patient."

One of the benefits of simulation is that students can experience and review the relationship they develop with the patient, a task that is deeply embedded in their abilities to communicate. A paramedic quickly learns that this trait is beneficial to the treatment of patients. Stated one student, "What I learned is that I need to make sure that I establish a patient vs. caregiver relationship immediately." Another stated, "I learned some helpful tips on how to better establish a patient/provider relationship." Still another stated, "I learned a more proper way to make the medic/patient connection and how that may benefit you on scene." In debriefing, students were often amazed to watch their own verbal and non-verbal actions that helped or hindered this relationship.

One of the important lessons from TeamSTEPPS and CRM is the adequate exchange of information between crews. As part of this, the MFR team leader must report off their findings to the paramedic team leader when they arrive on scene. During the debriefing, this report is critiqued by both identifying whether or not it was complete or

had missing information. Sometimes, in this process, it was observed that the paramedic team leader was given an excellent report, but didn't hear any of it due to inattention. Stated one paramedic team leader, "I learned that it is really easy to ignore other medical personnel on scene who might have pertinent information."

In communicating with patients, there may be a language or communication barrier built into the scenario. In response to a pediatric call where the patient didn't communicate well with the paramedic, they wrote; "[I learned] when there is a language barrier try to communicate better with parents." Students learned different communication techniques during the debriefs that aided them with future calls regarding communication problems.

Paramedics must also learn how to quickly communicate a patient's condition to other healthcare practitioners such as the physician in the emergency room. This is often done with a two-way radio (HERN) or cell phone. An advantage of the audio-video recording is that students could hear their own reports and improve upon them. Stated one student, "I learned more effective radio and communication techniques." Another stated, "I learned that I need to work on my HERN report to the hospital and that it should be the same report I give to the nurse at the hospital." Still another stated, "I learned that I need to follow a systematic approach when it comes to giving a HERN report."

Students also quickly realized how important documentation is during the simulations. One paramedic team leader stated, "I learned to remember to get a copy of MFR report before leaving scene. I learned this by not having it during the [HERN] report to hospital in the ambulance." As one of the tasks, team leaders must complete a

run report for each simulation they lead. These are corrected for accuracy and grammar. In some circumstances, they are returned to the student for resubmission once fixed. This was part of the learning process.

### **A Student View From the Control Room**

In the third and fourth year, a single student from each group was allowed to remain in the control room and observe from that position. They were given access to the script, full access to view the simulation monitors and sound, what was coded by the researcher, and observing of the simulation process from prior to the start of the simulation through the end of the debriefing. They were then asked to answer eight questions regarding what they observed.

#### Seeing the Big Picture

When asked whether what they saw was expected or different from what they expected, the answers were mixed. While one student indicated it was as they expected it to be, most related surprise at what they observed. One stated, “It was different watching them participating. You have a bigger picture and can see a lot more mistakes and differences between team [members]. It shows how it feels to see the whole picture.”

Another student stated,

It was a little of both [better participating versus better watching]. Based on previous sims where I came into the control room to observe when my role was finished, I mainly just watched what was happening on the monitors. Today, I watched more of what was happening with the controller. I was amazed at the ability of the person running the sim to multi-task at a lightning-speed rate as he gave life to the mannequin, changed the vital signs, provided sound effects and all the while typing in notes to be used for further training.

## Comparison to Being a Participant

When asked what was different for them as an observer as compared to being a participant performing simulation, most experienced a better and easier role from the control room. One student stated, “[There is] no tunnel vision, you get a bigger picture of the whole scene.” This was echoed by another, “You have a better picture of the scene. You see more mistakes and what you can improve on. You see how team members view their scene. You actually get to see everybody working.” Some students experienced unique insights from this vantage point.

As an observer, I had a better opportunity to see where critical keys were being missed and/or overlooked and how quickly a provider can be blinded by taking the wrong path thanks to a misinterpretation or misdiagnosis of presenting symptoms. By taking this forward with me in my career, I hope to be much more diligent and able to look at the ‘big picture’ that is painted when you add all of the little ones together.

While most students experienced this, there were concerns expressed by one student when they observed a huddle around the patient by the team members performing skills. During this time, they stated, “I believe it was much more difficult to observe and to hear the interaction between students from the control room.”

## The Script

Within this vantage point, students were given a script for the scenario, time to read it, and then asked to comment about it after the simulation had completed. Most commented that they were amazed at how many prompts were missed by students in the simulation that were clearly given from the control room using the manikin, props on scene, or dispatched information. As stated by one, “I noticed how the SIM HAL operator kept emphasizing a key phrase that would prompt something from the script. As



a participant, this was far less obvious.” The students also were amazed at the complexity and how thorough the script was written.

### Busy Sim Operators

In observing the simulation operators conducting the simulation, students voiced amazement at the complexity witnessed. “The operators were far busier than I thought they would be. There are a lot of little things to keep track of during and after the course of the SIM that never occurred to me.” Another stated, “They were good at catching things, good or bad.” Most experienced some of the organized chaos that the controllers of the simulation encounter while trying to follow the students’ actions with appropriate reactions from the manikin and simulation environment. Stated one student, “I basically just watched them moving their hands hitting this control button or that one, speaking into the microphone while giving life to the mannequin, and typing like crazy while making notes to use during the debrief.” Perhaps the best summary was as follows, “I noticed that there was a lot going on in the control room; seemed like a very hectic place to be during a sim.” I would personally agree with this student’s observations as a sim operator. When conducting a simulation, my focus is very intense on the task at hand and in trying to keep up with the students in the simulation.

### Observations of Classmates

One of the goals of this experience was to learn what students learned by watching their fellow students during the simulation. When asked about this, some interesting observations were made:

Watching the group go through the sim I got to see more of how they were thinking because I was standing back and taking it all in, I also got some new perspectives on how to approach these types of scenes in the future.

Another student stated,

It was quite a great experience. I was able to really see how the communication or lack of it plays a huge part in responding to patients. I was also able to observe how the dynamics of the differing personalities can also either hamper or enhance the communication process and the resulting patient treatment.

Some students expressed how impressed they were about teamwork in their group, “They [the teams] worked as a group. Their communication between groups [MFR and Ambulance] and the choice of treatment they used.” Yet another stated, “I was impressed how well the people work together during the sim.”

When asked whether they thought the learning was better from the control room or as a participant in the simulation, they stated,

I would say it was a different experience. A good one that you can see the whole picture and see how the group actually interacts with each other. You don’t have to focus on the patient, you can see the big picture.

Another student stated,

It was neither better nor worse—it was just different and I feel that both are valuable. I think that the students should be able to observe sims throughout the school year and not just at the end because being in the observation room for me helped to clue me in better to things that I would not want to do in the field as well as better define behaviors that exemplify professionalism and therefore confidence within the patient.

Finally, there were some who voiced a preference for learning by a hands-on approach doing the simulation, “I don’t believe that the learning was better being an observer; first off I knew what was going on and was going to happen, and secondly I learn better in a hands-on atmosphere.”

## Quality and Direction of Debriefings

One of the subjects often discussed by the simulation operators was quality and direction of the debriefings. After watching the debriefings, there were some interesting comments about the overall process. Stated one student,

I know that the sims lab is meant to be a positive learning environment and I definitely appreciate the “kudos” I receive when I do something right; however, I think more attention needs to be paid to the instructor’s concerns than what I saw today. I have always learned more from my mistakes in life than I ever have from the things I always (or almost always) do right. The instructor did an awesome job at leading the students to accepting responsibility for their personal actions without the students even realizing it was happening. I was surprised at the students’ belief that they “got the job done” even after watching the video played back. I could see, though, that they were taking in what the instructor was pointing out and in some I could see signs of recognition in their faces as they had an “a-ha” moment. The students seemed to be quite laid back and at times quite jovial—I know as a participant of the debriefing process that this behavior does help to alleviate some of the stress and/or frustration experienced during the sim. I was pleasantly pleased at the ability of the students to quickly process the treatment that would be given when considering the components that had been missed. In hindsight, this was a positive way to address the faux pas that had occurred.

Another student stated,

My biggest concerns about this simulation were the diagnostic clues that the students missed out on. I don’t really know who I could attribute to dropping the ball on this but I was really distressed at how vital information was overlooked. That being said, I know that I personally still have a lot to learn and that my skills are still “green” and I think that having the opportunity of being in the control room has helped me to fully acknowledge that. By being able to have a bird’s eye view to the sim and pick it apart, I was also able to personally reflect on my own abilities and skills and recognize those areas where I need a level of improvement.

In general, students expressed an unawareness that the debriefer was using a softer method of stating their mistakes until they viewed the debriefings from this vantage point. They also expressed insights into the debriefings that weren’t captured in previous data collections.

In summary, when students observed in the control room, most experienced a different viewpoint and learning points than when they were participants in the simulation. The ability to view from a distance allowed them to more impartially see what transpired in the simulation by their colleagues. As a result, they were able to reflect on some different lessons learned.

### **Observed Errors**

In Chapter 2, I discussed errors both within medicine and those that studies have found present in pre-hospital EMS. In this section, I discuss the errors that were found during the simulations in this study. Two major classifications for error systems have been presented earlier. The first was that described by Reason (1990, 1997) and the other was a summary of diagnostic errors (shown in Table 1) culled from various authors. I will discuss each in this area using examples that were witnessed in this study. In the last section, I discuss the more specific errors that were observed.

I think it is important to note that this section focuses on the mistakes that were seen. There were a lot more things done right by the crews than wrong in the simulations. In fact, during some simulations the crews were nearly flawless in their assessment, leadership, teamwork, communications, and medical treatment. All feedback given to the crews in the debriefing consisted of both good and bad things seen. In this section, I share only the bad things, missed sentinel events, or errors since this was where much of the learning appears to have come from. The reader should not adopt a skewed view from this information because the number of right things done by paramedic students far outweighed the errors overall. This compilation of errors is from years 3 and 4 data.

## Reason's Classification

Reason (1990, 1997) described latent errors as those which were caused by organizational policies or procedures creating potentially unsafe conditions. Within this study, the practices taught to students were such that no latent errors were found. Active errors, those caused by the direct actions of individuals, were abundant and represented the greatest number of errors observed. Within the active errors, involuntary, unintentional action, and intentional errors were all observed with a substantial number for each.

There were a number of involuntary errors that were observed. In one of the scenarios, a pregnant patient at the end of her third trimester was placed on the stretcher by the crew preparing to transport her. They began to see her blood pressure fall and light-headedness develop. The patient was suffering from supine-hypotension syndrome where the vena-cava is depressed between the fetus and the spine resulting in low return of blood to the heart. The blood pressure falls as a result. One simple treatment is to tilt the mother about 20 degrees to one side thus removing the pressure and allowing for blood flow. Within a number of crews, this action was not taken by the crew, resulting in an involuntary error. There were many involuntary errors observed similar to this.

Unintentional errors were also observed with frequency. Usually these involved a procedure or action not being done as planned. In some scenarios, the portable oxygen tank was seen to not be turned on when a non-rebreather mask was applied to the patient. This would result in hypoxia to the patient. In other scenarios, the CPAP (Continuous Positive Airway Pressure) device was applied to the patient only to not be turned on correctly. This resulted in no pressure to the patient and resulting hypoxia. Still in other

scenarios, the pressure-sensitive amputation leg did not have a tourniquet applied tightly. As a result, bleeding continued uncontrolled. All of these were some examples of the many unintentional errors observed.

Intentional but mistaken actions were also observed. One of the more common observed intentional but mistaken actions was in drug administration. Students would administer the wrong drug for a medical condition. I observed adenosine (chemical cardiac cardioversion drug) given for albuterol (respiratory bronchodilator), adenosine to slow the heart (the student believed that the patient's heart rate of 112 needed to be slowed down), and nitroglycerin given to a hypotensive chest pain patient (normally this is contraindicated if the systolic B/P is less than 90). There were a number of intentional mistaken actions observed in the simulations in all groups and cohorts.

### Active Errors

I introduced in Table 1 the active errors that have been presented in the literature for medical practitioners. In this next section, I will give the definition of each active error followed by examples where it was found in the study. There were some active errors that were not found during this study. These included; Availability bias, Feedback bias, Playing the odds, Psych-out error, Search satisfying, and Sunk costs. Examples were found for all of the other active-error types identified in Table 1.

### **Anchoring**

Anchoring is described as a premature lock on a patient diagnosis based on initial presentation and failing to change that diagnosis once later contradictory or non-supportive information is obtained (Kempainen et al., 2003, p. 179). This was seen a number of times within the study. For example, students were presented with a COPD

patient with chest pain; however, they misdiagnosed this pain as cardiac in nature rather than originating from tired, overexerted respiratory accessory muscles. As a result, they treated the patient for a heart attack, giving nitroglycerine, aspirin, and morphine sulfate instead of the needed continuous positive airway pressure treatment needed. There was no relief from the cardiac-based treatment.

In another example, students responded to a patient who was experiencing a narcotic overdose from pain patches to their body. Early on, the sister of the patient stated to the crew that she thought he had overdosed on Tylenol. The Medical First Responder team leader assumes that this is the true diagnosis. Later when giving report to the paramedic team leader, the paramedic team leader agrees with this diagnosis; however, team members identify the slow shallow respirations, pinpoint pupils, unconsciousness, and cyanosis. The paramedic team leader believes the Tylenol overdose is responsible until the debriefing. In the ER, when giving the patient report to the physician, this same team leader accidentally calls it an “aspirin” overdose. Students anchored on the original diagnosis and refused to change it, despite the non-matching evidence.

### **Ascertainment Bias**

Ascertainment bias occurs when the practitioner’s thinking is shaped by prior expectation. For example, during one of the year 2 simulations, there was a mechanical problem with the single HAL manikin we possessed. As a result, for a medical scenario, I substituted the Noelle manikin that is normally used for childbirth training. I reduced the girth so that the manikin did not appear pregnant. Despite this action, students persistently focused on her “pregnancy problems” despite the fact she denied being pregnant multiple times. The true diagnosis for this patient was influenza; however, the

teams continued to try to find obstetric-related problems to explain her symptoms because they knew she was a pregnancy manikin.

In another example, many of the simulations I designed dealt with patients who were critical in nature. To counter this, one of the sims that I designed was the “sick person” simulation. In this simulation, the patient could have a malady as simple as influenza with mild dehydration from the days of vomiting and diarrhea. Because students expect more serious scenarios, they are often deceived by this scenario. They look for and often find life-threatening conditions that aren’t actually present. This results in improper and occasionally life-threatening treatments. This scenario has been known to end with the patient in full cardiac arrest due to the care provided by the practitioner hunting for the serious disease.

### **Commission Bias**

Commission bias occurs when the practitioners believe that harm will result to the patient by a lack of action rather than no further harm by inaction. One example of this is a scenario involving a pediatric patient with epiglottitis. In this scenario, once the assessment for epiglottitis is made, the best treatment is to agitate the patient as little as possible while getting them to a hospital. If agitated, there is a potential for complete airway obstruction due to the airway swelling. Students, in their vigor to diagnose and treat all possibilities, will start an IV on these patients, examine the mouth, undress and assess the patient, and do just about everything you should not do; this results in a complete airway obstruction in about 40% of the simulations. The drive to do something, even if it is misguided, is stronger than remembering the first rule of medicine: Do no further harm.



## **Confirmation Bias**

Confirmation bias is the tendency for the practitioner to look for confirming evidence to support a diagnosis rather than disconfirming evidence to deny it (Kempainen et al., 2003, p. 179). In one of the pediatric scenarios, the infant acquires a viral infection that causes a high fever and febrile seizures. The mother of the patient recognizes that her baby is not breathing and is turning blue. As a result, she starts CPR, as instructed prior to leaving the hospital; she is not aware that this is actually a seizure, not a full cardiac arrest. When the EMS crew arrives, they are presented with a mother doing CPR on the patient. Rather than stop and assess the airway, breathing and circulation before continuing CPR, about a third continue the arrest until the baby starts crying a few minutes after being post-ictal (resting). The confirming evidence the rescuers saw was a mother doing chest compressions and ventilations on a cyanotic baby. Furthermore, it was dispatched to them as a “pediatric patient in full arrest,” thus creating the perfect recipe for a confirmation bias.

## **Diagnosis Momentum**

Diagnosis momentum occurs when once a possible diagnosis is attached to a patient by earlier providers or caregivers, the consistent repetition of that possible diagnosis cements to become the actual diagnosis, ruling out all other possibilities, regardless of the facts. In the earlier anchoring example, I discussed a narcotic overdose patient misdiagnosed by their sister as a Tylenol overdose. This diagnosis continued through two team leaders without change despite evidence that denied it. Diagnosis momentum had set this as the solution.

In another scenario, an asthma attack is triggered by dust in an office setting. The First Responders note that the person can't breathe and is complaining of chest pain. This is misdiagnosed as cardiac chest pain and treated as such. Even when the paramedic crew shows up on scene, despite evidence on scene, such as a medical alert tag indicating she has asthma, an inhaler has been used twice, and a textbook history indicating an asthma attack, the crew treats her as cardiac chest pain. Before long, due to the improper treatment of the patient, she will go into full arrest. Prior to the debrief, the crew believed that this was confirmation that they were correct in their diagnosis. They didn't realize that they caused the arrest by not treating her hypoxia and bad allergic reaction.

### **Framing Effect**

In a framing effect, the signs, symptoms and other manifestations of a patient start building a framework for a common diagnosis; however, in doing so, less common diagnoses are overlooked. In one of the adult respiratory scenarios, the crew is presented with a patient who has undiagnosed Tuberculosis (TB). The patient is found coughing blood-tinged sputum with a low-grade fever within a homeless shelter. The crew diagnoses it as influenza and transports to the hospital unaware that it is TB. As a result, no TB precautions are used by the crew, including masks and minimizing droplet contact. It was first framed by dispatch as a "sick person" later to be further refined as influenza by the crews. As a result, the TB diagnosis was overlooked.

### **Omission Bias**

An omission bias is a decision to not take action based on the concept of doing no further harm. However, in critical situations, the lack of action may result in additional harm to the patient. One example of this was found in an obstetric patient with a

prolapsed cord—a condition where the cord is partially delivered prior to the breech head of the baby. The pressure of the head cuts off its own blood supply through the cord. The correct potentially life-saving treatment for the baby is to assess the cord and insert a gloved finger into the vagina to maintain pulses to the cord. Several of the crews recognized the cord presentation as an emergency and made the immediate decision to “load and go” or quickly scoop the patient up and get them to the hospital with the emergency lights and siren on. In doing so, they didn’t monitor or treat the pinched cord, contributing to fetal demise. When asked in debriefing, most indicated they wanted to get the patient to the hospital as quickly as possible where she could be properly treated. They were unaware that their missing actions would have changed the outcome.

### **Overconfidence Bias**

Overconfidence bias is a tendency for the practitioner to believe they know more than they actually do. Often this relies on intuition, hunches, or a desire to act on incomplete information. Both anchoring and availability bias may be involved with this. In a pediatric patient with epiglottitis (a viral infection that swells the airway), the crew didn’t realize the observed drooling, cyanosis, and associated history was epiglottitis. Instead, they aggravated the patient by assessing the breath sounds, vital signs, moving them, removing clothing, until they degraded to a complete airway obstruction. This eventually led to a cardiac arrest. During treatment, there was still no recognition of airway obstruction as the cause for arrest. When calling medical control to get permission for a field termination of treatment, the airway compromise was suggested by the online medical control physician. Despite this and an order for an emergency needle cricothyrotomy, false information was reported back to medical control regarding the

presence of an airway when there wasn't one. The patient expired and the debriefing was long.

Two of the simulations that were specifically written to test for overconfidence bias were the pediatric and adult sick patient scenarios. In both of these scenarios, the patient essentially had a moderate case of influenza; however, the treatment for that by some students ended in full cardiac arrest in the patient. Their confidence that this was something more than what was presented resulted in a multitude of errors in giving treatments that were unnecessary.

### **Posterior Probability Error**

A posterior probability error is the tendency for the practitioner to misdiagnose a condition/disease because of previous patient presentations or diagnosis. In these previous presentations, similar signs/symptoms resulted in the same diagnosis each time. As a result, the bias is towards the same diagnosis again rather than ruling out other potential causes.

A female patient who was presenting as a "sick patient" was diagnosed as influenza even though she was actually having abdominal pain of a cardiac nature. She gave in her history that she wasn't sure if it was influenza since it was similar but not the same. A 12-lead ECG should have been done to help rule out a heart attack; however it wasn't. In the debriefing, when students were asked why they didn't do it, they answered, "It was the flu. She didn't have chest pain." It is known that a segment of the female population with a heart attack will never have any chest pain but instead will have abdominal pain; however, in this instance the crew didn't consider this because they linked it to a previous diagnosis.

## **Premature Closure**

Premature closure is the practitioner's decision to prematurely determine a diagnosis excluding all other possible causes. A common maxim is, "When the diagnosis is made, the thinking stops" (Croskerry, 2003, p. 778). As an example of this, in one of the scenarios a patient develops uncontrolled atrial fibrillation at home. In this instance, the heart rate drops to 40 beats per minute, which causes bouts of unconsciousness followed by normal waking cycles. In this scenario, the patient is found on the toilet with blue legs after he awakes in a sitting position unable to move his legs. One of the crews that responded to this call determined that his blue legs were caused by a circulation problem. They treated him based on this despite the fact that they had a ECG monitor on the patient that was clearly showing atrial fibrillation varying from 40 to 70 beats per minutes. During the slower heart rate, his level of consciousness would drop and he would state to them that he felt funny. The team leader replied, "You may have some blockages in the legs causing this problem." They had prematurely closed on the diagnosis of leg circulation problems and as a result could not see that uncontrolled atrial fibrillation was at the root of his problems.

## **Unpacking Principle**

The unpacking principle is a failure to obtain or consider all relevant information when establishing the differential diagnosis. The missing information may be the pertinent information which changes the diagnosis. I saw this many times in a lot of different scenarios. For example, the crews failed to do a 12-lead (or even 3-lead) ECG on a patient with chest pain. Another example was the failure of crews to put an SPO2 monitor (a device that measures oxygen in the bloodstream) on patients who have

difficulty breathing until very late in the call (18+ minutes). Attaching this monitor takes about 10 seconds. Yet another example is not checking blood glucose levels for an unknown unconscious patient. A final example is not checking breath sounds on a patient with shortness of breath. All of these are examples of things missed that would have helped students get the correct diagnosis.

### **Visceral Bias**

Visceral bias is an affective-domain-based bias on the part of the practitioner towards the patient due to negative or positive feelings. As a result of these feelings, the practitioner may ignore potentially catastrophic diagnosis in favor of less severe diagnosis which they favor. This has also been described as a fundamental attribution error as a result of countertransference. One possible example of this occurred in a scenario involving a 19-week pregnant patient involved in an auto accident resulting in a miscarriage. In this scenario, though the student discovered multiple pieces of information suggesting a miscarriage (abdominal pain, wetness at the perineal area, vaginal bleeding, mild hypotension, patient stating “I feel a clot” [referring to vaginal blood] and asking “Is my baby okay?”) the paramedic treated it as a routine auto accident, although he did start an IV. In report to the ER physician, the paramedic continued down the routine accident pathway. After ending the scenario, when pushed by the instructor, the paramedic team leader stated, “It could be uterine rupture, but I’m not sure.” There was never a visualization of the pubic area or a check for blood, despite red marks on the car seat.

In a related issue, during assessments of obstetric patients in their third trimester, there was a noticeable reluctance to examine the female perineal area, especially by male

paramedics. This was despite clear signs/symptoms of problems requiring visualization such as bulging (head pushing at the underwear), contractions, feeling of bowel pressure, and more. In one birthing scenario, the head actually completely popped out of the vagina and created a very large and noticeable bulge in the mother's pants. It wasn't until this point that the male team leader decided to expose the patient for the first time nearly 12 minutes into the scenario. I witnessed a definite reluctance for male paramedic students to expose this area in simulation.

### Specific Errors

In this last section on errors, I discuss some of the more common specific errors that were witnessed throughout the 4 years of simulation. This list was compiled from the simulations conducted in years 3 and 4. I have broken this down into two major subcategories: technical and non-technical errors. The technical errors are those that are medically related. These include Assessment, Safety, Medication, and General Medical. The non-technical errors include Communications, Situational Awareness, and Leadership. In addition, I provide some examples where and/or how these errors were made.

The focus of this section is on the errors made; however, I would remiss in not pointing out that I saw students do more right than wrong during this study. Some of this was as a result of their reflecting and learning from previous actions in simulations. As a part of this study's design, I repeated the COPD simulation students took in their first module again in their last module, with minor changes in the setting and patient history. The differences in reduced call times, quality and fullness of assessment, quality of leadership, and quality in communications, teamwork, medical treatment, and situational

awareness were astounding. It was very clear that the students had learned and improved in their abilities from the first to last simulation.

In years 3 and 4 of the study, 173 simulations were conducted. The simulations were scored using the criteria listed in the sample simulation found in Appendix A. Students' results in these simulations ranged from near perfect scores to utter disasters. The next sections document the errors found from very minor to life-threatening. In previous sections, I described how and what the students were learning. This section shows the actual content of the errors that served as the basis for their learning. They made these mistakes in the sim lab so that they didn't make the mistakes when presented with a real patient in need.

### **Assessment Errors**

In order for a paramedic to develop a plan, they must first properly assess the patient. In simulation, a lot of errors in assessment were observed. In this section, I discuss those specific errors.

In obtaining a patient history, I noticed that a lot of the students did not use mnemonics such as SAMPLE (Signs and Symptoms, Allergies, Medications, Past Medical History, Last oral intake, and Events leading to the incident) for initial assessment or PQRST (what Provokes pain, Quality, Radiation, Severity, Time) when asking about pain. Because of this, they often missed important data that were needed about the patient to help determine a diagnosis. Besides not asking the specific questions when a problem was found, such as a history of diabetes, there were no follow-up questions such as "Do you take insulin? When and how much insulin did you last take?"



During the assessment of a patient, vital signs (heart rate, blood pressure, respirations, level of consciousness, skin condition, pupil response, breath sounds, and temperature) are measured. One of the most commonly missed vital signs was checking the pupils. During assessment of pulse and respiration rates, some individuals “guessed” at what they were feeling rather than using a watch with a seconds hand to get an actual measurement. In other cases, the presence of breathing was assessed but not the rate. As a result, patients who were breathing at six breaths per minute were not assisted in their ventilation rate until later in the simulation—resulting in hypoxia and potential injury. During assessment of the blood pressure, often the B/P was significantly different from what had been programmed; for example, in one scenario the students reported a B/P of 158/100 when it was 180/120. This also occurred with pulse rates; one student reported a pulse of 80 when it was 120. The manikins are designed to mimic blood pressures and pulses within a few percentage points of what is programmed. Finally, one of the reasons for assessing vital signs is to monitor the patient’s progress over time. A common problem was that groups would get an initial set of vital signs only to wait until the end of the call—if at all, to repeat the process.

When assessing the patient’s respiratory system, lung sounds should be checked with a stethoscope to determine their health. Different medical conditions, such as fluid in the lungs, create different breath sounds. The manikins can recreate most breath sounds; however, the student’s interpretation of those sounds is often incorrect. This leads to administration of medications such as albuterol to correct wheezes when they aren’t present. Another related problem is that students will often assess the front breath sounds but not the back. As a result, they missed major differences needed for a correct

diagnosis. Finally, often while assessing the breath sounds of a patient, another team member will be asking the patient questions. As a result, this can interfere with what is heard by the person assessing the breath sounds—thus resulting in an inaccurate assessment of what is heard. Incorrect assessment often leads to incorrect diagnosis.

One tool possessed by the paramedics is a patient monitor that can aid in assessment and monitoring of a patient. It can even be programmed to repeat assessments such as blood pressures on a regular basis. In simulation, I saw many errors using the monitor. Besides not using the B/P monitor early in a simulation, one of the most common errors is the awareness to recycle the blood pressure (if not preprogrammed). As a result, students will often read a normal (but 10 minutes old) blood pressure for a patient that in actual time has a falling blood pressure. Hitting the “stat” button on the B/P switch would re-measure a current pressure. Besides the vital signs listed above, the patient monitors have the capability to measure physiologic items such as the electrocardiogram (ECG that measures the electrical system of the heart), pulse oximetry (the measurement of oxygen carried by the blood), and end-tidal carbon dioxide exhalation levels (the waste product of cellular respiration). These data can be vital in determining what is wrong with a patient. Unfortunately, a lot of errors were witnessed using the patient monitors.

In using the ECG, some students were observed putting the limb leads on the wrong limbs. This would result in an incorrect tracing that can result in the wrong interpretation, depending on the rhythm or abnormality. This was observed in both limb and chest leads for 3-, 4-, and 12-lead ECG’s. There were also times where leads would be incorrectly placed on the chest during a 12- or 15-lead ECG. In addition, there were

times where a 12-lead ECG was warranted by the patient's condition and was not performed due to an error in leadership decisions.

In the actual interpretation of an ECG, often the students were seen observing that the patient had an electrical pulse on the monitor but not interpreting what the actual rhythm was. As a result, in several simulations, the patient with an atrial fibrillation rhythm that was causing a hypotensive crisis was never diagnosed by the crew. Some crews did diagnosis, but not until they were in the ambulance on the way to the hospital.

In a related problem, often the students didn't watch the monitor for changes during a simulation. During a simulation with a patient in full cardiac arrest, the patient was intubated and CPR was momentarily stopped to verify lung sounds that indicated the endotracheal tube was correctly placed. During that time, the patient was in an organized normal sinus rhythm due to a successful previous intervention. This was missed by the team leader and all team members. CPR was restarted on a perfusing beating heart.

One of the most valuable tools is the use of pulse oximetry and end-tidal carbon-dioxide monitoring. Placing the pulse-oximetry attachment to a person takes about 5-10 seconds and involves attaching a small clip to a finger. Immediately, it tells you the oxygen availability in the red blood cells. Yet, despite this, on respiratory cases it was noted that a number of the students attached this device very late (10+ minutes into the call) or not at all. Likewise, the end-tidal carbon dioxide monitoring involves attaching a small cannula at the nose. This takes under a minute to complete. This tool was used in less than 10% of all simulations by the choice of the crews and team leader. Even after explained to the students, there was a reluctance to use it despite the fact that it is known to make a difference in diagnosis. The decision to use it was almost always a late one,

usually half-way through the call. Often it involved use as a secondary confirmation for the correct placement of the endotracheal tube.

Within the simulations, obstetrics was a major focus consisting of at least six simulations that the student would be exposed to. There were a number of common obstetric-based errors that were observed in the simulations. During the limb presentation, the patient was often transported supine, without a pillow under the buttocks. Because of the presence of supine-hypotension syndrome (a falling blood pressure due to the fetus depressing the inferior vena cava), this was contraindicated. If transported supine, the correct position would be having the mother slightly on her left side with an elevated buttocks. While not in the protocols, many obstetricians and hospitals recommend transport in knee-chest position. Almost all students made this common mistake in simulation.

Another common obstetrical problem involved monitoring the duration and interval of contractions. Some students didn't do this at all despite that it is an assessment skill that was taught and recommended. In those who did, rather than timing these with a seconds hand, the vast majority of crews would simply "guess" at the duration and interval. These data are predictive to how imminent the delivery may be. In a related assessment, asking the number of previous births and pregnancies was a question often missed by the students in simulations. There is a direct relationship to the rate at which a birth progresses and the number of previous births.

Finally, starting in the first year, I noticed that there was a real fear or unwillingness to exposing the female perineum when indicated in obstetrical emergencies. While this tendency occurred in both men and women, men seemed to have

the greater tendency not to perform this task. In multiple simulations, the head of the baby had actually fully delivered and was resting in between the patient and the underwear/pants bulging while the neck and body remained in the birth canal. When asked in the debriefing, one of the men stated, “I saw the bulge and wondered what it was—err—at first?” This was after the patient was screaming during her contractions that she thought the baby was coming. In the next 3 years, I watched the students’ reluctance in this task.

I have listed some of the more common assessment errors that occurred. I have not listed *all* the errors that occurred. These assessment errors contributed to other mistakes made since they served as the foundation data from which students often determined the illness, condition, or injury that they were dealing with. While assessment errors endanger the patient, there are other errors that endanger the crews as well. In this next section, I will discuss the safety issues that resulted from these simulations.

### **Safety Errors**

Of the errors that were observed, those involving safety were of prime importance during the simulations, and every occurrence was addressed in debriefing or on-scene if the error was a serious risk to the students. These safety errors all had the capability of injuring the patient and/or crew due to their nature. I have sorted these by the category of equipment which they are involved with.

One of the major devices that EMS personnel use on a high number of patients is oxygen therapy. This often involves bringing a portable cylinder of oxygen onto the scene of an accident so that it can be immediately applied to the patient. One common error that was observed was to stand the portable tank on its end on a table or hard

surface so that any accidental jarring or contact could cause it to fall over, striking the unprotected regulator head on other objects. This could result in an gas decompression that would be dangerous and harmful to all those present in the room.

With the actual administration of oxygen, there were a number of safety errors observed. Often a mask was applied to the patient but not turned on at the tank. As a result, the patient rebreathed their own expired air thus decreasing their overall oxygen content from what was in the room air while increasing their carbon dioxide levels in the blood. This would also happen if the tank ran out of oxygen and was not monitored by the team, as it did in several simulations. When moving from the scene to the ambulance and the ambulance to the ER, the patient is often transferred from their portable oxygen to the ambulance's larger oxygen tank. During this process, the oxygen must be disconnected from one regulator and attached to another. Often this process took some time and the oxygen appliance was left on the patient, resulting in hypoxia. This occurred with both non-rebreather masks and Continuous Positive Airway Pressure (CPAP) devices.

One of the highest items of use by an ambulance crew is that of the ambulance stretcher, which is used to move the patient from the scene, to the ambulance, and to the ER. In the use of the stretcher, several drops of the patient from a standing height to the ground were observed. Also, the cot was observed being loaded into the ambulance backwards by two different crews in simulation.

In moving the patient from where they are found to the cot, safety is of prime concern. In some scenarios, the crews were witnessed carrying a patient across a room rather than moving the cot to them and shifting them over. This movement over open air,

sometimes called “hang time,” is dangerous since should either of the crewmembers lose grip, the patient will fall straight to the ground. If a cot is under them, there is less chance for injury. In addition to increased “hang-time,” there were a number of moves that were unsafe for both the rescuer and patient. One of the more common ones was the rescuer picking up the patient alone and cradling them to the cot. This can cause serious injury to the back of the rescuer as well as result in both falling to the ground. Lastly, some unfamiliarity with the cot was observed in a number of the crews. As a result, the loading or unloading process was longer than required and often unsafe since they would be observed fumbling for a cot release to allow the stretcher legs to deploy while holding half the weight of the stretcher and patient.

I discussed earlier that the use of the patient monitor in assessment was an often overlooked, underutilized and improperly utilized device in simulations. It was also involved in safety violations. One of the most common safety errors was not setting upper and lower limits on physiological parameters for the patient. As a result, if the heart rate or breathing fell below a dangerous limit, there was no warning to the paramedic. Crew members would have to be observant of the monitor while performing other tasks that could result in tunnel vision and disregard for the monitor. There were a number of scenarios where changes on the monitor were not detected for 10 or more minutes until after they had occurred. In debriefing, the teams were often amazed that they all had missed these changes.

While I will cover specific communications errors in an upcoming section, there were several communications errors that were life-threatening in nature. The first was unclear radio traffic or not telling dispatch that they were on scene. These mistaken

communications meant that if a crew was in danger either on scene or en route, dispatch would not be aware exactly where they were. As a result, it would be more difficult to get them help or duplicate units may be dispatched looking for them. Proper communications is a safety measure for EMS.

A final safety issue that was observed on scene was in personal safety. During the TB scenario, the majority of crews never donned an N-95 mask capable of protecting them from a patient with tuberculosis. Crew members then climbed into the back of the enclosed ambulance and received contact from the patient who was spitting up blood-tinged sputum and coughing. If they applied the CPAP mask to this patient, it further aerosolized the infection. In a related personal safety issue, several of the responders were seen not wearing disposable medical gloves but had direct patient contact with potential bodily fluids. This is a transfer risk to the rescuer for infection.

Safety is of prime importance to EMS workers since maintaining a safe environment results in less injuries to the patient, the workers, and others on scene. Within the scenarios, the safety issues listed above surfaced as common problems that endangered these individuals. In this next section, I'll discuss related safety issues involving medication administration.

### **Medication Errors**

One of the areas within the scope of practice for the paramedic is the administration of medications to the patient. Within our simulations, a number of errors were observed in medication administration. These included administering the wrong medications, wrong dosages, and errors in the administration technique.



The wrong medications were observed administered to the patient in many scenarios. Within the TB scenario, aspirin was administered to the patient who crew members believed was having a heart attack because of patient's grasping of their diaphragm and chest. A patient who was suffering from an Atrial Fibrillation rhythm was given Lasix (a diuretic). Narcan (used to counter narcotics) was administered to a patient with a self-inflicted aspirin overdose. These were some examples of the wrong medication being used.

Even if a medication is given for the correct reason or diagnosis, it may not be indicated for administration due to patient findings. In simulation, a patient who had taken Viagra should never have been given nitroglycerin when they were suspected of having chest pain, since this is contraindicated and can lead to an uncontrolled hypotension. Likewise, Zofran (a medication that decreases nausea and vomiting) was given to a patient who had suffered an aspirin overdose. In this situation, vomiting might actually reduce the amount of aspirin absorbed in their system. These are two examples of several where the right medication was actually wrong for use in the scenario with the patient.

Even when the correct medication is given for the correct patient in the right circumstances, there can be errors. The wrong dosing, whether it be overdose or underdose, was observed in simulations. For example, in the administration of magnesium sulfate, a dose was given to an obstetric patient of one gram instead of 2 grams over 10 minutes for seizures, despite the seizures recurring. This did not reach the therapeutic range for this patient. In a pediatric seizure, an overdose of diazepam was given at 2.5 mg instead of 1.9 mg, due to a math mistake. In yet another patient, the 2 mg

of morphine sulfate was given to a patient with an obvious hip fracture prior to moving her. Unfortunately, it too had not reached the therapeutic level resulting in greater amounts of experienced pain for the patient. In this scenario, the therapeutic range had been established to be at 6 mg of total dose. The paramedic never rechecked that the pain had decreased by the use of a pain scale. Both calculation errors, not using resource materials such as the Braselow tape for pediatrics or consulting written protocols, and knowledge inaccuracies resulted in the medication dosing errors observed.

Finally, a number of errors in administration technique were observed. These often started with the improper starting of the intravenous (IV) fluid in the first place. Occasionally these IV's were not in the vein. Because the manikins were not able to store the administered fluid, students didn't know if the IV was in the vein or not until checked by an instructor afterwards. The assumption in simulation was that they were properly started until denied later by direct confirmation; however, other IV-related errors could be readily visualized. Students were observed not removing the tourniquet that was used to help start the IV. As a result, I would often tell them that blood was backing up into the IV tubing. Likewise, a number of IV's either came out or would have become dislodged due to improper securing (taping) of the IV. In scenarios, the IV would be discontinued if this occurred—requiring a restart.

Once an IV is properly established, a medication is often administered either directly through that IV or using a second fluid bag (containing medication) attached to the first one. The piggyback medication bag is supposed to be higher than the primary (original) IV solution. Often, students erred by leaving it the same height as the primary solution. The likely result would be that half the dose of medication was administered. In

another error, intravenous medications that were injected were often given too rapidly. As a result, side effects like flushing, palpitations, and nausea and vomiting were seen.

In some simulations, the order of medications given was incorrect. For example, during the hip fracture scenario, pain medication is warranted by the patient's condition prior to moving her. A side effect of the pain medication is often nausea and vomiting; however, another medication, Zofran, can mitigate this side effect—as long as it is given prior to the administration of the pain medication. In simulations, it was often observed to be not given at all or given after the administration of a narcotic.

One of the most serious medication errors that was observed was in administering the medications without proper monitoring equipment in place. This included not getting a full set of vital signs prior to administering a medication, not having the patient on a monitor, not monitoring serial vital signs (B/P, pulse, respirations) during administration of drugs, and not paying attention to the vital signs prior to administering a dose of medication. In one scenario, the patient was becoming hypotensive (low blood pressure) as a result of administration of a narcotic (morphine sulfate). The paramedic student administered another dose of the narcotic, causing the patient's blood pressure to crash to a dangerous level. There was a lot of learning in that debriefing.

The medications that paramedics administer can be lifesaving in nature; however, the safe administration of these medications requires practice. Within simulations, the direct observation of this administration allowed for very clear evidence of correct and incorrect practice in this skill as well as feedback to the caregivers. In these last few sections, I discussed the assessment, safety and medication errors observed. In this next section, I discuss the medical errors that were observed in simulations.

## **Other Medical Errors**

Besides the medical errors already listed, those that remained I grouped into this category. These errors were those witnessed during the simulations by students. These included Airway, Oxygen administration, CPAP, BVM, CPR, Bleeding control, Extrication, Immobilization, and Obstetrics.

In establishing an airway, a number of common errors were observed. In several different scenarios, during the use of a bag-valve-mask to ventilate the patient when they were unconscious, a pillow was left under the patient's head. This resulted in an anatomic airway obstruction where the tongue muscle falls back and occludes the airway. Unfortunately, it was often late in the scenario that this error was corrected. In the pediatric drowning scenario, the 1-year-old is found submerged and drowned in the bathtub. Many crews failed to clear the airway of water prior to giving the first ventilations to the patient.

Even in scenarios where the patient was breathing and had an adequate airway, attention was not paid to the body position that affected the airway. For example, in the chronic obstructive pulmonary disease (COPD) scenarios, the patient is using their accessory muscles (those in the chest) to help them breath. Students were observed placing the patient supine on the stretcher, disabling the use of those muscles in breathing. As a result, their shortness of breath was further intensified.

One of the airway adjuncts that is used by paramedics to maintain an airway is the insertion of an endotracheal tube. This tube is passed down the throat, through the vocal cords and into the trachea where a cuff is inflated. By doing this, better control over the airway is maintained in the unconscious patient; however, if the procedure is done

incorrectly, it can result in hypoxia or death. During one of the pediatric scenarios, paramedics were observed inserting and ventilating the patient through a tube that had been passed too deep into the lungs. As a result, it was lodged in the right main stem bronchi resulting in ventilation to half of the lungs. This remained undetected for up to 3 minutes and 30 seconds by crews in years 3 and 4. In other scenarios, it took several intubation attempts on adults and pediatric patients before successfully intubating the patient; however, at no time in years 3 and 4 were any incorrect intubations not detected by the crews. In years 1 and 2, there was one intubation that remained undetected until the ER.

Besides maintaining an airway, often oxygen is used to aid the patient in breathing. In some scenarios, though strongly indicated by the patient's presentation (hypoxia, cyanosis, shallow rapid breathing, or slow breathing), it was withheld until 10-20 minutes into the scenario due to leadership errors. In other scenarios, oxygen was applied with a non-rebreather mask to a patient who was absent a pulse and breathing. Unfortunately, for a non-rebreather mask to work, the patient must be breathing!

Besides a non-rebreather mask, one of the devices that can be used to give oxygen to the patient is a continuous positive airway pressure (CPAP) device. While EMT's and paramedics are trained in its use, there were a number of observed errors in simulation involving this device. Among the most common observed errors was difficulty in applying the device because of the different straps and unfamiliarity with the specific device. Often this would result in an inadequate seal to the patient's face, resulting in effectiveness. When properly applied to the patient, often the oxygen setting to the device

was either too high (resulting in the device's blow-off valve whistling) or too low (resulting in ineffective pressure).

There were some serious errors observed when using the CPAP. Generally, once applied to the patient, this device should be continued until removed by the order of a physician. This means that it should be transferred to a portable oxygen tank when the patient is moved to the ER; however, some crews were observed disconnecting the oxygen while leaving the device on the patient's face. As a result, no oxygen would be flowing and the patient would breathe their expired air, resulting in increased hypoxia. In addition, many crews were unaware that they could use the CPAP with a nebulizer (a device for administering medications to the patient in an aerosolized form).

A number of times the CPAP was used inappropriately. This included applying it for low oxygen saturations due to severe hypotension caused by an uncontrolled atrial fibrillation rhythm or a patient with respiratory rate inadequacy such as a patient with a narcotic overdose breathing at six breaths per minute. In these situations, the CPAP device would have been ineffective.

One of the airway devices that is used to force air into the lungs in a patient who is unable to do that is a bag-valve-mask (BVM) device. There were a lot of errors observed with the use of this device. The use of a BVM is indicated when the respirations fall below 10-12 breaths per minute or breathing is too shallow and ineffective. In simulations, this device was often not used on patients with a respiratory rate of six per minute. Likewise, the BVM used should match the patient size: adult-sized BVM on adults and pediatric-sized BVM on pediatrics; however, adult BVM's were used on

young pediatric patients in simulation. This can result in over-ventilation and pressure, both of which were measured in the pediatric manikin.

For a BVM to be effective, it must be properly applied to the patient. BVM application errors included not having an adequate seal, giving inadequate volume (too much and too little), using an inadequate or irregular ventilation rate, and performing the tasks while the patient's head was on a pillow, creating an anatomic obstruction. One of the advantages of the manikin is that it senses the neck position and reports back the airway volume and pressure. As a result, a direct reading of the effectiveness can be given to the students during the debriefing. During the debriefings, students were often questioned on why the respirations were inadequate. One of the most common replies was that they did not monitor the chest for chest rise during the ventilations. Another issue that was observed was that when students had inconsistency in ventilation rates, they were often distracted by another task such as aiding a colleague with a procedure or watching something else in the room. Not remaining focused on this task was shown in simulation to be a serious problem.

Lastly, one of the side uses for the BVM was believed to be as an oxygen concentrator for "blow-by" oxygen in pediatric patients. Depending on the specific make of the BVM, this may or may not be a valid use. BVM's are often attached to oxygen and contain a small device called a concentrator that allows a tube or bag to fill with oxygen. When the BVM refills after being depressed, that concentrated oxygen becomes the source; however, if the bag isn't depressed it won't refill with oxygen. Some students mistakenly held the bag mask near the patient thinking it was blowing oxygen to the infant. This was a false premise and resulted in no benefit.

One lifesaving technique is the use of cardio-pulmonary resuscitation (CPR) which consists of the artificial ventilation and external compressions of the heart by rescuers. During CPR, students were observed doing compressions with an inadequate rate, depth and location. High-fidelity manikins measure the effectiveness of rate, depth, and hand location from what they actually receive from the rescuers. Errors such as leaving the patient on a soft mattress, inattention while moving, and ineffectiveness are all directly measured by the manikin for use in the debriefing. This is a major benefit of high-fidelity simulation.

During CPR, students were also observed inadequately assessing the ABC's prior to the initiation of CPR. This resulted in performing CPR on a person who had a pulse and was breathing, but was merely unconscious. Along with CPR, an automatic external defibrillator is often used by Medical First Responders. Students who often acted in that capacity forgot that they had the AED available or used it late after discovery of pulselessness in the patient. Once an AED was in place, at times the paramedic team leader did not switch to their monitor upon patient contact until late in the simulation. I observed an AED being used for three shocks by a paramedic crew before switching to their monitor for a rhythm interpretation.

Several of the simulations presented involve controlling external bleeding as part of the management. Within one scenario, the patient's leg is amputated. While all crews treated this with a tourniquet, several delayed that treatment or did not make it tight enough to be effective at stopping the bleeding. This was despite blood ejecting from the amputated leg. In an unrelated simulation, the patient cuts their wrists, resulting in external bleeding. A few of the crews did not bandage the wounds sufficiently to



maintain pressure and bleeding control. Capillary refill and circulation checks were not assessed post-bandaging to make sure the bandage was not too tight.

One of the skills used for trauma is extrication and the application of a backboard. In using a backboard, often the cervical (upper) spine is damaged, requiring a cervical collar to be applied around the neck. In some simulations, though indicated, it was not applied due to errors in leadership. In other situations, prior to the application and restraint of the patient to the backboard, the cervical spine was allowed to move, potentially causing injury prior to the application of the device. As an adjunct device, often a Kendrick Extrication Device (KED) is used to help remove a patient from a vehicle and onto a backboard; however, in simulations the straps used on this device were often too loose to be fully effective. This would result in possible movement of the spine and further injury to the patient.

Splinting and immobilization are used in one of the simulations. In a hip fracture, often crews choose to use a muslin binder to apply pressure to the hip and reduce pain. In simulations, this binder was often too loose to be effective when checked in the ER. Also, in that same scenario, pain management was often not in high enough doses to be effective.

One of the specialized areas of medicine involved obstetrics and gynecology. Paramedics must learn to assess and treat these patients who present with unique problems not observed in the rest of the patient population. Because of this, a number of unique problems were observed in this area.

During normal cephalic (head first) childbirth deliveries, the students were often observed being unprepared for the actual delivery. I discussed earlier how students (often

male) were reluctant to expose the perineum of a mother about to deliver. This was a contributing factor to not being aware that the mother was delivering now. As a result, the students were observed not having the emergency OB kit (bulb suction unit, blankets, umbilical cord clamps, etc.) available, opened, and ready for use. In simulation, the team leader would often bark, “Get me the OB kit” which was left in the ambulance—despite being told it was a pregnancy issue. In one other case, a lack of situational awareness and hoping not to deal with it resulted in the crew quickly loading the patient into the ambulance as the head popped out between the mother’s legs—still with her underwear and pants on! These calls made for some interesting debriefings.

Part of the obstetrics simulations was to expose them to unusual but life-threatening or sentinel event-type calls. One of these scenarios was a prolapsed cord where the umbilical cord is birthed prior to the head of the child. This can cause the cord to be trapped between the vaginal wall and the head of the fetus, cutting off blood supply to the newborn. In this situation, students should place several fingers into the vagina and create a channel for blood to flow to the infant until birth can occur; however, in simulation this was often not done or done improperly. Many students didn’t understand how to maintain a channel with the fingers until it was discussed in the debriefing. Likewise, they didn’t understand the concept behind what they were doing or the proper assessment of a pulse within the cord itself. These were definitely learning experiences.

There were some errors in obstetrics where the wrong procedure was used for a specific problem. In a *placentae previa* simulation (where the placenta is blocking the birth opening resulting in bleeding), a crew was observed putting the mother in the knee-chest position (used for breech and foot presentations) for transport. This did no benefit

for either the mother or baby. Likewise, a patient was transported in the prone position with hypotension caused by that body position. Simply putting her slightly on her left side would alleviate the problem; however, the crew would instead start additional fluids and even administer dopamine in one situation during the first year. In several of the pregnancy-induced hypertension simulations, the crew was unaware that the patient had preeclampsia until they witnessed the first seizure. In one case, it was mistaken for a cardiac arrest and CPR was started. Had they had the patient on the monitor, they might have rechecked their “pulseless” verification that lasted for 3 seconds.

In these past four sections, I shared some of the common medical or technical errors that were observed in simulation. Because there were a wide variety of simulations designed and conducted, there was an equally wide array of errors observed. In this next section, I will focus on the non-technical errors involving situational awareness, communications and leadership.

### **Communications Errors**

One of the most vital skills a paramedic must possess is that of ability to communicate. This is done using a variety of different tools including language, technology, emotional intelligence, and more. There were many communication errors observed in these simulations. In this section, I break down the most common ones observed.

Radios are used by EMS workers to communicate with dispatch, the hospital and other agencies/resources. As part of the simulations, students carried a two-way radio which was recorded for use in the debriefing. The use of this radio was problematic for some students. Some had difficulty remembering to depress the button when talking, or

would speak too close or far from the microphone. Some would talk before they depressed the microphone, cutting off part of their communications. A team leader would state in the debrief that they knew they had called dispatch upon arrival only to find out that no transmission or acknowledgment of that transmission was ever received by either the dispatcher or student. The recordings were excellent evidence of radio effectiveness.

The use of radios was treated in simulations as it would be in real life. If a crew forgot to call out, a few minutes later the dispatcher would ask, “MFR1, what’s your ETA to the scene?” They would quickly state they were there. If a unit forgot to call out that they were leaving the scene, the dispatcher might call them while en route in the ambulance for a “welfare check” (inquiring if they were okay on the scene). Again, they would state, “We forgot to call en route.” Also, often crews would turn down their radios to the point where they couldn’t hear them. As a result, they would miss communications sent to them resulting in follow-up by dispatch or other entities (police, ambulance, etc.). All of these would be discussed in the debriefing.

An important radio communication is the HERN (Health Emergency Room Network) report from the ambulance to the ER giving them information on the patient they were transporting. This report describes the patient condition and treatments administered, and requests any further orders from the physician who will be accepting the patient. In simulation, this HERN report was occasionally forgotten. As a result, a very angry nurse or physician might greet the crew, asking why they hadn’t been contacted so that they could prepare their busy ER? In other cases, the HERN report was given poorly. As a result, critical information was missed that was vital for the ER to be aware of.

One last radio item that was of importance was the use of crew-to-crew communications. Often, the scenario information that the crew was dispatched with was inaccurate but was based on the information given to the dispatcher by the caller. As a result, when the MFR crew got on scene, they would discover something totally different. Giving a “heads up” call to the ambulance crew responding can change their thinking. Often this was forgotten by the MFR crew. For example, in the pediatric febrile seizure scenario, the call is originally dispatched as, “a pediatric cardiac arrest with the mother doing CPR on scene.” Immediately, the MFR and ambulance crews both realize this is a critical call and their thought processes start racing. In actuality, while the mother is doing CPR on the patient, it’s actually a seizure that occurred due to a high temperature. When the MFR crew arrives, if they check the infant’s airway, breathing, and circulation, they will find all present. Most communicate this to the ambulance crew at some point. Some never do, resulting in an ambulance crew that comes through the door in a mind-set to work a full pediatric cardiac arrest. In the debrief, they often have some less-than-fond words for the first crew regarding the lack of radio communications in this call.

Besides radio communications, EMS workers must give oral reports to each other and those around them including the hospital physician. Within the simulations, I looked for whether there was adequate transfer of pertinent information. Often, this was missing in a report. For example, in an ER report to the physician, the paramedic never tells them that CPR was performed by the mother on the febrile seizure patient they just brought in. The use of CPR on a healthy patient can have adverse effects that the physician could assess for—as long as they knew CPR had been done. In another similar report, the prescribed use of lithium by a manic bipolar patient was never transferred from the

paramedic to the physician. In yet another report, the wrong disease of asthma was reported for COPD in a patient, though the treatment was done correctly. Again, errors in communication were present.

One of the observations I made was that often when errors in communications were made, it was due to a report being given without written information as a source. When notes were present, the report was more likely to be accurate. This was especially true when trying to recount medications, past history, and allergies to medications.

One last oral report mistake that I witnessed came as a result of using the Against Medical Advice (AMA) form. EMS workers carry a legal form that patients who refuse treatment must sign prior to EMS leaving the scene. In a couple of scenarios, this form is used. In both instances, some paramedics would have the person sign the form without explaining the consequences of their actions or additional options that they have. As a result, legally, they were not fully informed—which was evidenced by the electronic recording used in debriefing.

Written reports are a communications method that are required for every EMS call that is encountered. Within the simulations, it was the responsibility for both team leaders to turn in a separate report on the call. These were reviewed and feedback given to the students after the module was over. Errors found in this reports included improper grammar, wrong times, missing information and procedures, missing signatures, and inadequate documentation of events. In some cases, the penmanship was so poor that a revised report was requested a second time because it was not legible. These reports are legal documents in actual calls.

As part of the teamwork aspects of training, communications techniques are discussed. The lack of use of closed-loop communication was emphasized in the debriefings when found. Within the simulations, there were times where a procedure or piece of information was found and even told the team leader, but never actually heard due to their focus on something else. These came out in the debriefings.

One of the last communication errors that I will discuss involves the use of non-verbal communications. During the introductory simulation lecture, an in-depth discussion about emotional intelligence and non-verbal communications occurs. Despite this, paramedic students in simulation breach many of the learned lessons, often without even being aware.

Students are expected to establish a health patient-provider relationship in their patient encounters. In simulation, I often see students talking to the patients standing upright while the patient is lying or sitting down. This creates a towering effect that is intimidating to some patients. Getting down to their level (kneeling or sitting), looking into their eyes and providing communications that are caring and compassionate help to establish a positive patient-provider relationship. Towering was often seen in the simulations and the students became very good at spotting it in themselves. Cold uncaring behavior was witnessed by several of the students in earlier simulations. After feedback and discussion, this usually changes, supporting the effects of affective domain learning in students.

In the simulations, often communication-related things were said or done on the scenes that were inappropriate. This included laughing or giggling around a seriously ill patient (misconstrued as uncaring or laughing at the patient) and stating inappropriate

phrases like “uh-oh” when discovering something wrong (for the patient, this can be distressing). Students often forget how their actions are perceived by others—especially the patient and family members.

In this last section I discussed some of the communication errors observed in the simulations. These are very important aspects for EMS workers to master. In this next section, I discuss the situational awareness, something that is needed to provide adequate leadership.

### **Situational Awareness**

Situational awareness is the perception of the patient’s condition, environmental elements and changes over time that are occurring. In short, it is a full awareness of all events occurring within a scene. Within this study, in most simulations, situational awareness for the students was actually quite good. During the study, each simulation was tracked to determine whether or not the team leader had situational awareness. In year 3, team leaders had situational awareness in 46 of 60 simulations (77%). In year 4, that awareness was present in 87/113 (77%) of the simulations. Just under a quarter of the time (23%) was awareness lacking.

Lack of awareness resulted from a number of different causes. Poor assessments often resulted in a lack of significant information needed to determine the correct diagnosis and treatment. When this was lacking, either a wrong diagnosis and treatment occurred or the wrong diagnosis but correct treatment occurred. The later I nicknamed the “Forest Gump Syndrome” because despite being oblivious to the situation around them, students still took the correct actions, even if by accident. For example, in the Pediatric Epiglottitis scenario, a crew performed almost no assessment, gave some blow-by oxygen



and transported the child in the mother's arms to the hospital without lights and siren. Nothing they did upset the child and, as a result, though they were totally oblivious to the diagnosis, no further harm occurred to the patient; however, this was not the case for all.

In most of the scenarios where situational awareness was poor, this often led to very bad outcomes due to errors in treatment. In the depression scenario, the crew responds to a "sick patient" who has actually taken up to 400 aspirins in an effort to kill herself. She is experiencing nausea and vomiting and calls the ambulance to make it stop. After questioning her for 10 minutes, the very emotional patient states, "I have to go to the bathroom. This isn't working." If the crew makes the mistake of letting her go unattended, she will close the door and slit her wrists resulting in a confrontation to either break in or coax her out. In about two thirds of the times this was run, she is successful at a second suicide attempt. In another example, in a pediatric shooting, if the crew does not get the patient to hospital or helicopter in 20 minutes, he/she will expire due to injuries. The goals in this scenario are rapid assessment, treatment, and transport. A number of crews make the mistake of treating the patient on the scene, often taking 30 minutes or longer, resulting in a bad outcome.

Situational awareness is also reduced by mistakes of a critical nature. For example, crews often make the mistake of leaving a critical piece(s) of equipment (drug box, IV kit, and monitor/defibrillator) on scene in their haste to depart, only later finding the critical need for it en route. I mentioned earlier in the *Situational/Perceptual Awareness* section and *Context* section about how inattention and change blindness affected both the leader and team members in this study. Often, team leaders would allow themselves to get tasked with a skill such as giving a medication or applying an ECG

only to be totally oblivious to significant changes in the patient due to tunnel vision or change blindness. These conditions reduced the situational awareness of the leader and served as reason to delegate when possible.

Having situational awareness and knowing the correct diagnosis still doesn't necessarily mean success on the simulation. I observed excellent situational awareness on the part of the leader along with excellent diagnosis but inadequate or incorrect treatments resulting in bad outcomes. Situational awareness alone does not in itself guarantee success; however, it does significantly improve the odds of it. For situational awareness to be of value, it requires proper medical care and leadership. For that reason, in this last section on errors, I will discuss the leadership errors observed.

### **Leadership Errors**

As I stated earlier in the study, there is a lack of leadership training in EMS for paramedics. As part of the material the students were subjected to in this study, leadership was taught to them. In the practice of this leadership, students were observed making errors. These included errors in planning, resource management, directing, and critical thinking.

In planning, one of the most common errors is the belief by students that they can enter a scene without a plan and it will miraculously appear as you treat the patient. This delusion is quickly realized when the situation goes bad. In the debriefing, one of the things I ask the paramedic team leader after their initial MFR report is "What was your plan?" If they state they didn't have one, I've often found the reason for errors we're about to discuss. On subsequent team leads, this improves.

Besides the lack of a plan, other planning errors are observed. In simulations, the team leader will not follow or consult the treatment protocols for a particular diagnosis once discovered. Students are encouraged to bring copies of the protocols either in their phones or in written form with them to simulations, since they would do the same in the field; however, when asked why they didn't consult them when unsure, the most often response is that they didn't think to do it.

Often a team leader will construct a very precise plan of action prior to getting on the scene, based on the dispatch information. A lesson they quickly learn is to make sure that their plans are able to be quickly changed. For example, in the pediatric febrile seizures, when team leaders didn't receive pre-contact from the MFR team leader that the call was not a full cardiac arrest, they would often come into the room with a plan to manage that arrest. When they found that no CPR was being done, it created a temporary panic that subsided as they heard parts of the report. Then, I would witness a long pause as they tried to figure out what to do next. There was no backup plan should this patient have a pulse. Some of the expressions on the team leaders' faces in this instance were priceless.

As part of the planning process, knowing what equipment to bring onto the scene is important and will vary slightly depending on the type of call. Often, crews were observed bringing equipment that was not needed or not bringing equipment that was badly needed, despite pre-arrival or dispatch information received. As an example, I mentioned earlier the frequently forgotten obstetrics kit when presented with an imminent delivery. In another example, a crew showed up for a cardiac arrest without their medications bag or suction, both of which were badly needed on this call.

Another important task for a team leader is in resource management; that is, using resources effectively and efficiently. One of the most common resource management issues involves equipment. Besides not bringing the correct equipment to some scenes, there is often an unfamiliarity with the equipment itself. In simulations, just trying to find an item was often challenging for the team leader. I watched during one simulation as the team leader kept dumping things out of their jump bag trying to find a blood pressure cuff. In other scenes, I would watch as 10 minutes or more were spent trying to find an item. Knowing where something is can be one of the most important resource management tasks.

In addition to physical resources, knowledge and efficient use of people resources is also an important leadership skill. There were often times in the simulations where entire groups of students were seen standing around un-tasked with anything while the team leader did everything. While I discuss this more below, using people wisely was not always observed. As part of that, one of the resources an EMS team leader has is the Medical Control Authority. These are physicians who are available by radio or cell phone to the team leader for consultation during a call. Yet, when confronted with situations in which the diagnosis or treatment was unclear, many team leaders were observed to guess rather than ask for help.

A good team leader directs their team. At the beginning of year, team direction was much worse than at the end. Errors in directing included not giving any direction at all to the team. As a result, either everyone would start freelancing (doing whatever they thought was appropriate), stand around waiting for direction, or attempt to subvert the leadership by taking it over from the team leader. I saw stronger leaders often emerge

who directed the team in place of the assigned paralyzed team leader. These weaker or inexperienced team leaders had to be coached on how to lead in the debriefing.

In directing their team, good team leaders delegate jobs to others around them. In the simulations, I noticed that some team leaders would allow themselves to become quickly overloaded or task saturated to the point where they could no longer effectively lead. Often, the simple solution was to coach them into delegating more or doing a better job communicating with others. The desire to do the skills rather than delegate was a strong theme in early leadership experiences within simulation.

The last leadership errors I observed were in decision making or critical thinking skills. A leader must assess the information they have collected and then make good judgment-based decisions to act on that information. Unfortunately, in simulation, I saw many errors in the decision-making process. These included errors in diagnosis and treatment, errors in transport priority and destination, and in not changing plans. I have already given an adequate number of examples on diagnosis and treatment errors in previous sections. I will focus on errors in priority and patient destination and in not changing plans.

One of the most important elements of EMS is transporting the patient from the place they are found to a hospital capable of giving them further care that is needed. Choosing the correct hospital and deciding how quickly to get them there are decisions each paramedic must decide. For example, if a patient is having a ST elevation myocardial infarction (STEMI) or heart attack, it makes sense to take them to a hospital that has a percutaneous coronary intervention (PCI) capability in as little time as possible. There they can quickly get the blockage removed and circulation restored to the heart. In

simulation, some team leaders treating patients with chest pain did not perform a 12-lead ECG to diagnose the STEMI. As a result they went to the wrong facility. In other cases, the STEMI was diagnosed but they chose to go to the closest emergency room which didn't have PCI capabilities. This resulted in the patient being transferred to a PCI hospital and more unnecessary time added before they got the treatment they ultimately needed.

The decision to transport a patient using lights and siren immediately incurs greater risks for accidents and injury, since it involves going through red lights and traveling at faster than posted speeds. In simulation, the decision to transport *Priority I* was misused a number of times. In some cases, it was misused because the paramedic didn't feel secure treating the patient due to a lack of experience or knowledge. In other cases, it occurred because of a perceived threat that wasn't present, such as the patient getting worse following the correctly applied treatment. Even when the decision to transport *Priority I* was correct, often I would observe the crews spending 4 minutes in the ER entrance untangling cords, switching over oxygen, and performing other tasks to get ready to unload. Many of these could have been done en route, resulting in the saved time (by going through lights and siren) being lost while sitting in a parked ambulance in the ER entrance. This was shown to students in the debriefing, and often they were totally unaware of the amount of time it took until then.

Often a decision was made to transport a patient *Priority I* to the hospital after spending a long amount of time on scene treating the patient. Within the debriefs, this brought out the point of the value of doing treatments on scene versus those same treatments en route to the hospital. There is a lack of logic in saying you must shave 3

minutes off your transport time when you spend 30 minutes on scene treating the patient, especially when many of those treatments had no benefit on scene versus in the ambulance.

Besides transport by ambulance, one of the resources at the disposal of the paramedic can be the use of a helicopter to transport the patient to a hospital. This involves contacting the helicopter early in the call so that they can fly to the scene. In scenarios where a helicopter was warranted, it was often not called until late—increasing the time before the patient would be seen at the hospital.

One of the last points in leadership involves revisions to plans. Often in the simulations, the paramedic team leader didn't realize they needed to modify their plan. For example, during the toxic inhalation, a paramedic crew is on standby for a fire department extinguishing a structure fire. When a firefighter is dragged out of a partial collapse in the structure, the crew is activated to transport this patient. One of the responsibilities of that team leader is to call another ambulance to the scene so that it can stand by in their place. Only one crew did this out of all of these scenarios that were run. When asked, the other team leaders didn't realize this action as part of the larger picture.

### **Summary of Specific Errors**

In this section on specific errors, I have discussed many of the specific errors I observed primarily in years 3 and 4 of this study. These errors represented the actual content-based errors that were observed in the students' actions; they show the lessons learned as a result. These same errors could have been made in the pre-hospital setting on live patients for the first time. Instead, they occurred in the simulation laboratory with the ability to review them using audiovisual technology and facilitated debriefing feedback.

## **Learning About Simulation Technology**

In the context, I discussed how the simulation technologies were used and developed throughout this study. In this section, I go a little more in depth on the advantages and disadvantages I experienced in the study regarding the simulation technologies that were used. In addition, I discuss what we learned about the different elements used to produce a high-fidelity healthcare simulation. I learned it was more than just throwing a manikin into a room. In essence, we learned what we didn't know within this process. I do this to provide the reader with an understanding of the limitations we all experienced (participants, staff, etc.) when conducting this study.

### **What Manikins Do Well**

There are a lot of advantages to using manikins as a substitute for live patients. There was an interesting parallel in evolution of the manikins while we were doing this study. From years 1 through 4, additional features and functions were added by the manufacturer to the manikins that were used. These additions helped solve critical needs in using this technology. In the context data section, I discussed how the first Noelle manikin didn't have a voice. It became almost impossible to communicate between the patient and student without this—especially given a static manikin. We added a wireless intercom to her so that we could talk to students. The receiving unit was implanted in her head with a speaker near her throat. Necessity was the mother of invention for us. By year 2, the manufacturer had developed streaming voice technology that was incorporated into Noelle, replacing this makeshift voice. With the exception of the premature and newborn babies, having a streaming voice on the manikins was a critical feature to do the type of work we did.



One of the greatest advantages to using the high-fidelity manikin is that they allow for medical procedures and treatments, such as cardiopulmonary resuscitation (CPR), intubation, defibrillation, pacing, intravenous fluids administration, medication administration and more without the danger of harming a live human. This is a critical ability; paramedics must be able to perform these skills efficiently and quickly when needed. This requires practice and external feedback. It would be impossible to practice these skills on a live human without the potential for serious harm. Clearly, high-fidelity manikins shine in this area.

Another advantage is that while imperfect, manikins are able to mimic many of the human functions in the field. Many of the manikins used have eyes that react to light and blink on a regular basis. This simple action allows for practitioners to monitor whether or not their patient is conscious or unconscious just by a quick look at their face. In addition, there are modifications that while not being exactly like those found in a human, are close enough to establish the suspension of disbelief for most participants. Examples of this are the abilities to turn blue in the face—representing whole-body cyanosis; the ability to talk with an implanted speaker—allowing for practitioner-patient dialog; and the gold placements on the chest for conduction-pad placements to use electrical equipment on the manikin. While these weren't exactly like a human, they were close enough as a human analog.

A major advantage in the high-fidelity manikins is their ability to allow for unusual procedures to be done with control by the operators. For example, the Noelle manikin allows for the student to practice the complete childbirth sequence from their initial encounter to the point at which they hand off in the ER or OB department. I don't

know of any live humans who can deliver a child on queue and at a pre-designated time. This is in addition to allowing for the performance of those situations where sentinel events have occurred such as a cord presentation or *placentae abruptio*.

### What Manikins Don't Do Well

One of the greatest drawbacks to the use of the high-fidelity manikins is their lack of ability to mimic human facial gestures and body positions “on the fly” or in real time. This is a real problem in simulations since humans make many gestures and facial expressions that give feedback on how they are feeling or responding to care. While we alert the students to the fact that while the manikins can blink, have reactive eyes, and speak, their facial movements are fixed. If a medical practitioner came across a person who had a fixed facial expression similar to the manikins, they would likely suspect a stroke or some other neurologic malady.

One of the assessments that students perform is a neurological assessment on patients. Included in this assessment is whether or not the patient can feel sensation in the arms and legs, flex their toes and fingers, grasp with both hands equally, and more. These are assessments used to help determine the treatment required. Unfortunately, the manikins don't do any of these. As a result we had to do a work-around, which was less realistic but accomplished the task. When students did these tests, either my co-instructor or I (who was often playing the part of the manikin's voice) would respond to their questions or state that they just saw the feet/hands do the action appropriately or inappropriately. It was a work-around.

Likewise, there are body conditions that the manikins don't mimic well; for example, swollen ankles, purse-lipped breathing, pulsing umbilical cord, pitting edema,

and decreased capillary refill time in the fingernails or toenails. The use of Post-it notes was invaluable for this function. For the student to see the Post-it note, they would have to expose that area or perform that task before they would be given the results. While this was less realistic, it accomplished the assessment needs of the student.

In some of the physiological functions, the high-fidelity manikins also had some problems. While they did an excellent job of providing a pulse, breathing and electrocardiogram, for some students hearing the lung sounds accurately was an issue. One of the problems when listening to lung sounds is that there are other transient sounds, such as Velcro snapping, plastic rubbing, and pneumatics functioning, that detract from the lung sounds produced by implanted speakers in the chest and back. For some students, these transient sounds made it very difficult to hear the correct underlying lung sound. One of the work-arounds I found very helpful was to spend some time with the students assessing different lung sounds on the different manikins. This was done during the introduction simulation scavenger hunt and in some subsequent modules. The lung sounds often helped change the therapy chosen and became an important parameter to get correct.

### Technology and Failure

One of the things I've learned from working with technology such as simulation is to always have a backup plan. I'm a firm believer in O'Tool's commentary on Murphy's law (everything that can go wrong will go wrong), "Murphy was an optimist." Within the simulations, I realized that we didn't know what we didn't know. This is especially true when it comes to technology and "glitches."

We experienced a lot of glitches and technology failures throughout this project. Some I have listed, many I have not. Examples of this included: manikins dying (when you didn't want them to) for various reasons, manikins not doing what you programmed them to, video recordings stopping in their record cycle in the middle of the simulation (thank God for the "back record" button which restarts the recorder starting with the previous few minutes), props breaking, equipment malfunctioning, real tornado and fire warnings occurring during a simulation, floods in the sim lab, power failing in an environmental simulator, and more. All of these required a "plan B" or even "plan C" while simulations were being conducted in real time. Throughout all of this, the simulations continued to run.

Probably the best lesson to share is that I had many opportunities to cancel a simulation or give up entirely on this process, especially in the first year. I didn't. Instead, I first looked for a quick solution to get us through that simulation, then I looked for the root cause and fixed it. Often, we would also put into place changes in our operations to prevent it from occurring in the future. If this looks familiar, it is; it's the Crew Resource Management model at work. Because of this model, our simulation startups are quite different today from what they were in year 1—not only from a technology standpoint but also a process standpoint. That didn't just happen, it took planning, perseverance, patience, and occasionally a little luck. The long-term benefits far outweighed the frustrations and costs.

### Use of Standardized Patients

As we entered our second year, we knew there were scenarios that we wanted to do, but couldn't because of the limitations of a high-fidelity manikin. For example, we

wanted to have a manic patient, however the manikin was unable to walk, let alone move quickly through the apartment (living room simulator). I decided to use a standardized patient—that is, an actor or actress who is trained how to mimic the illness or injury of a patient. This was used for our geriatric fall scenario (in which a hip was fractured), a suicidal depression patient, and a bipolar patient who discontinued their medications. All of these required movement in the patient along with facial gestures.

Students were quite surprised when they encountered these patients. In fact, that act alone served as a distractor for some who were uncertain about how to proceed. Prior to using these patients, we discussed with the students that these patients would wear a nude colored body suit that would serve as their skin and protect their modesty. We also instructed that no invasive techniques could be performed on them. If an invasive technique were used, we would do everything except the actual piercing of the skin. Alternates such as tape for an IV rather than actually starting the IV by penetrating the skin were used on standardized patients.

One of the advantages of using the standardized patients was that the patient monitors used on them in simulation could still be controlled from the control room. What this meant is that after attaching the monitor to the patient, we could alter the vital signs to match what was needed for the script. This gave control but authenticity to the scenario.

Within this study, the use of standardized patients was extremely effective. Scenarios where a standardized patient was required often did not require a multitude of invasive procedures. As a result, using the standardized patient in place of the high-

fidelity manikin served as an additional methodology to accomplishing the specific simulations.

### Environmental Simulators

One of the goals of this study was to recreate to the best of our ability the setting that EMS workers practice within. To do this, we created a living room/bedroom, bathroom, ambulance compartment, control room, emergency room, multipurpose room, debriefing room, extrication simulators, and pediatric room. All of these were used in the simulations within this study. In hindsight, there were two simulators we would have added to the lab. These would have been a kitchen, where many accidents occur, and an industrial area. We used the outside pad to duplicate some of the industrial accidents; however, we realized that more could have been done in both of those environments.

One of the learned lessons was to purchase very hardy furniture for use in the simulators. Over the course of the study, the coffee/utility table was replaced once after receiving a great deal of wear in simulations. We also learned that having additional plugs and phones were handy within the simulations. For instance, we placed a recorded cordless phone in the living room that came in handy to speak to the actor/actress/instructor during a simulation.

We learned early on that at times four fixed cameras are insufficient to capture all of the action. One of the disadvantages of our earlier sim lab was that these cameras were fixed to specific simulators. When a student decided to contact medical control outside of the apartment door, we might lose that action since the simulator did not have a camera hard wired in that location. In our new lab, this was no longer a problem as the switch and control panel allowed selection of any of the 64 cameras. In addition the

preprogrammed screens gave a touchscreen-driven menu that allowed for different options when within various simulators. The flexibility in this new system allowed for us to capture action in two different simulators simultaneously—something that is extremely handy.

When students were working on a patient, often they would form what we affectionately called a “huddle” around the patient—mimicking a football huddle where all you see is derrieres in a circle around the patient. Unfortunately, this cut out the ability to see specific procedures being performed at times. The addition of a pan-tilt-zoom (PTZ) camera aided in being able to see between individuals and catch some of the action. In addition, these were critical in being able to see if a particular skill was being performed correctly or an item was turned on. This is strongly recommended for anyone doing this type of medical teamwork training.

### Creative Props

We learned very quickly in the first year that props used in a simulation could make or break the simulation. These props would fill the back-story of a character or become part of the team leader’s conundrum to figure out why they were there. These props came from actual broken medical equipment, donated items, garage sales, store items and more.

In year 1, we realized that having our HAL dressed in a hospital gown or the same shorts all the time without shoes (provided by the manufacturer) was not very realistic. In later sims, the students would often cut off clothing in their zeal of exposing injuries. We quickly found this to be an expensive habit and purchased Velcro tear away clothing for the manikins—something that saves the budget and allows for ease in dressing the

manikin. Soon each manikin had its own drawer of clothing that mimicked what humans wear. This included shoes, socks, underwear, shorts, long pants, T-shirts, polo shirts, and more. Props made the manikin look more real.

In addition to clothes, on scenes certain items were needed to sell the story. In the apartment, we provided ashtrays, burnt-out cigarette butts, and smoking paraphernalia to paint the picture that the pediatric patient's asthma attack was triggered by their visit to their sitter who was smoking. Would the paramedics recognize this and remove them from the environment? That was a sim question the students would answer for us.

When working with the pediatrics at home, we made sure there was a crib, changing table, toys, and other items you would find in a home with a child. Women don't carry drugs on scene in their pocket, but they do occasionally carry them in a purse—therefore our female patients had purses. Often patients wear a medical alert tag so that medical personnel can quickly know their ailment if found unconscious. We purchased a box full of different medical alert tags and use them regularly for the patients.

For about a year, we became known as the empty drug collectors in our college. Fellow employees and family members were asked to donate their old pill containers and used inhalers to the sim lab. We always defaced any identifying information before using them in the simulation. In real life, often a patient won't give paramedics a full history; however, the medications they are on will suggest the possible history. Students learned this lesson in simulations, thanks to the donations.



## Down the Rabbit Hole

One of the things I learned quickly as simulation operator is that despite all of your planning, preparation and guidance, when conducting simulations, students often don't do what you expect them to do. The question is how to respond to them. I use a metaphor from Lewis Carroll's *Alice in Wonderland*. In this story, Alice goes down the rabbit hole and enters a whole new world where adventures begin. In a sense, our students who perform simulations do the same thing when they start each simulation. While the sim operators may create the environment, the students clearly select the rabbit hole.

In some ways, once they enter that rabbit hole, they encounter additional rabbit holes; that is, they make decisions on patient management that impact the outcome of the patient. Early in the simulation project, I ran across some simulation advocates who felt an instructor should never allow the student to kill a patient in simulation. The belief was that it caused psychological harm and destroyed confidence. I had done simulations prior to this project that had, in fact, killed the patient both through student errors and as part of scenario design. In making this decision to follow the student down the rabbit hole as the simulation operator, I also had to make the decision whether or not to allow the potentially lethal consequences of their actions. I, in fact, made the decision to do this at the beginning of the study after consultation with several others—some of whom would not allow a patient to die regardless of the action.

Within the study, I realized that there were consequences for these actions. By allowing the patients to die when inappropriate actions, procedures, or medications were applied, students would learn the lesson that this was a dangerous action. They would

also suffer some affective domain issues. I learned this lesson when I ran the pediatric drowning scenario with a group. The team leader made a number of very bad decisions that resulted in the death of the patient. Following the simulation but prior to the debrief, the student was seen on the bumper of the ambulance looking down at the ground. He was in grief over losing the patient due to his actions. I had to debrief him for his feelings before I could perform the debriefing with the rest of the group. I learned that going down the rabbit hole and allowing the consequences to be what they may have a price; however, the benefits far outweigh the disadvantages.

The choice of going down the rabbit hole should not be seen as selecting the right or wrong rabbit hole, because it often isn't. Students may select to begin their treatment of the patient in the back of an ambulance while en route to the hospital rather than increasing scene time. Others, may select to treat the patient, then transport with the patient. Neither answer is necessary right or wrong—but the simulation operator needs to be ready to respond depending on the direction they go. The merits or mistakes in their decisions can be addressed in the debriefing, once all have emerged from the chosen rabbit holes.

### Teamwork Among the Sim Operators

One of the lessons I learned early in this simulation process was that conducting the simulations, acting as the voice of the manikin, acting when necessary in a scenario, coding the simulations, and running the debriefings was too much to effectively do by one person. In performing the modules I quickly realized I needed an assistant to act as the voice of the manikin, aid in controlling the computers, and help with the overall simulation process.

My simulation co-instructor throughout this process was Julie Masten, someone I will always be grateful to. What I didn't know that I didn't know was that she would become a vital part of conducting the simulations. Because she was also a licensed experienced practitioner, she served as a second set of eyes on treatments and procedures during the simulation. She also did a lot of behind-the-scenes work while I was debriefing the students so that the next simulation would start quickly after the end of the debriefing. In short, one of the things I learned about conducting simulations that I didn't know is that you need at least two people to do it well.

Another thing I learned as a simulation operator is that there is a right way and a wrong way to start a scenario. Through trial and error, we developed a set of rules and start-up sequences much like the checklists pilots use in flying an aircraft. Things like keeping non-simulation conversation out of the control room during simulations result in more successful simulations. Wearing a headset with one ear slightly uncovered allowed us to talk to each other without impeding what we hear in simulation. Having no speakers in the control room results in less extraneous sounds heard by the participants when the operator talks through the manikin. All of these lessons and more were learned in the process of learning what we didn't know.

### **What Students Say They Learned**

Throughout this study, there was a perpetual process of trying to understand what and how students were learning using the simulation process. In the final exit interviews, I asked the students to tell us what they had learned. This section describes some of the resultant answers. In addition, I have added a few comments from their fourth-year evaluations as well when appropriate.

## Experiencing the Uncommon Clinical Experiences

Within the scenarios, a number of sentinel events (or those life-threatening situations that are more rare and where the paramedics' actions/inactions can make a difference) were written into the scenarios. The goal of this was to build students' repertoire of calls to include these life-threatening situations so that if confronted with them in the field, they would know what to do. Within the comments, students voiced appreciation for this experience. Stated one student,

It gave me an opportunity to see things that are uncommon that you might see in your career, and that's probably the biggest thing about the sim lab . . . you see things that you wouldn't normally see and that you need to know how to handle. [From] my standpoint, [in] lecture I have a hard time concentrating, so having this is more important. It keeps you actively involved, so you're actively learning. It's not trying to absorb information versus doing it.

Another student stated in his video exit interview,

Getting both the types of sims that weren't going to be commonplace in a real world setting but were critical that you know, a breach presentation, a traumatic arrest, you know the—the amputations, those sorts of things, the pediatric gunshot. A pediatric gunshot, which was something that I hope I never see but want to know what to do in that case. And then the debrief process where Chet was able to say okay, here's what the sim was intended to show you. Here's the—the actual diagnosis that we created within the sim. Here's what your field diagnosis was. He may ask you, Did it match? why you did it, why you didn't do something, and based on that, the treatment that you initiated, you know the transportation priority and all the HERN reporting. Every single step of the process you have an opportunity to evaluate yourself, to have an instructor say good, bad, or indifferent. Here's what I would've done differently. Here's where you were right on. Here's where you missed the target. So to have that feedback and again, have it be someplace where I didn't kill anybody, you know, I didn't—I didn't make a mistake that ultimately resulted in a poor outcome for my patient, that takes a huge weight off me. That's the one thing on my first time doing clinicals, especially the person in the first semester of the program. I'm like walking in the ER for the first time as a medic student and I'm like, ahh, okay. Don't—Don't screw up\_\_\_\_\_. Don't hurt anybody. Don't make a mistake because you can't do that here. And then having someplace where you can do that is a huge learning benefit to me.

Students appreciated having an exposure to less common but more serious calls they would be required to manage in the field as a paramedic.

### Self-Knowledge and Evaluation

In earlier sections, I discussed that students often didn't know what they didn't know. As it turns out, even when they thought they knew something, they often found they didn't when put to task in simulation. I believe it was this increased self-knowledge and self-evaluation that led to further learning. Even when errors were pointed out by the debriefer, it took self-evaluation of those errors to implement a change in their thinking process. For example, one student stated:

It could be humbling in some ways and a confidence booster in others depending on the situation and the audiovisual feedback. It can reinforce the skills that you were maybe a little shaky on. Um, it can be humbling because if you think you know exactly what's going on in the patient and there's something you missed that was invaluable, then it can kind of limit your ego, so to speak, and it can be a confidence booster if you didn't think you were doing so well and you had a good outcome for the patient because you relied on the skills you knew you had.

When faced with an imminent childbirth, a student commented about his/her experience,

When I realized that I was going to be expected to assist with a field delivery, I kind of panicked. The instructor validated for me that I had performed in the manner in which he had anticipated and that I need not fear the situation should I come across it in the future.

One student commented on his/her first leadership experience:

I learned that I really didn't have a clue. As I watched the video, I could see how truly dumbfounded I was because I was standing back doing nothing—kind of scratching my head since I wasn't sure what to do.

Still another student commented about a mistaken drug dosage he/she was responsible for:

That I need to be stronger in regard to my knowledge of drug dosages. I also need to feel more confident in myself when asked questions so that I don't

read too much into a question. Trust myself. Trust what I know. [I learned this by] not feeling confident in that area and approving/agreeing on the wrong dosage.

In the end, students expressed awareness at the amount of self-growth and learning that had taken place. One student stated,

I learned how far I have come over the course of this past year. Once it was revealed that this was the same SIM that we started the year off with and the instructor pointed out areas where we had improved and acknowledged how much more smoothly we were working as a team, I learned that I need to believe in myself and my abilities as a paramedic.

Perhaps this student stated it best, “That everyone is human and makes mistakes and to learn from them.”

#### Objective Evaluation of Skills

I witnessed a real love-hate relationship in the comments I shared during the debriefings regarding their performance. Many students hated or were nervous about the experience of being watched while making mistakes; however, once they realized that there was no penalty for making them, they actually enjoyed knowing how they did.

Stated one student,

It gave an opportunity to physically do the things that I was going to be doing as a paramedic, to use the critical thinking skills that I was developing as a paramedic student, and then to have somebody immediately evaluate, and then not have the subjective evaluation. It would be an objective evaluation. The one thing that I did get more so with ALS agencies, less so with the hospital setting, but I got some evaluation at the end of the clinical or at the end of a particular run, but it tended to be subjective evaluation the medic would make through offhand comments about well, I think he did this or I don't know if he said that to the patient, I'm not really sure if he understood. In this setting, you've got the audio, you've got the cameras, you've got Chet and Julie actively involved in the sim, so when we go to the debrief, it's very objective. They're able to say this is what you were doing. This is what you said you were doing. Now, tell me why and what was the intent and that sort of stuff, so that in that objective what you got was huge.

This student clearly appreciated the objective evaluation process they received in debrief. This comment was one of several encountered regarding this concept. When asked whether or not the students felt fairly treated in the simulation and debrief, the overwhelming majority stated “yes.”

### Assessment Inadequacies

There were a lot of comments about the ability for students to perform assessments on live and high-fidelity manikins during a simulation. While the skills of assessment are practiced within lab-based learning, the ability to see it within the holistic treatment of the patient contributed to learning. One student stated,

[I learned] where I was lacking in certain areas of the sim. For example the assessment questions . . . OPQRS and SAMPLE, and some of the other important questions that would have helped us better treat the patient.

Another stated, “I . . . learned the importance of fully evaluating the patient to choose the proper treatment prior to making finalized treatment options.” Still another commented following a team lead in a simulation,

I learned that I need to evaluate my patient and do things differently so that I was closer to the patient, the MFR’s were a lot closer and I could not get close. (I was by the door and the MFR’s were next to patient; I should of asked them to move so I could get closer).

Finally, another stated, “That I need to work on completing a full SAMPLE, history, and OPQRST at one time and not throughout multiple times.” In the simulation they were part of, instead of following an organized pathway to asking questions, they were more random, which resulted in missed questions and less gathered information from which to make a diagnosis.

## Specific Procedures and Treatments

One of the most important aspects of being a paramedic is the knowledge of when to apply specific medical procedures and treatments to a patient. Much of what students say they learned in simulations involves the learning and practicing of these procedures and treatments.

In obstetrics, students voiced appreciation for the experiences working with the Noelle high-fidelity manikin. One student stated, “[I learned] the mechanics behind prolapsed cords and the best way to maintain cord perfusion.” Another stated, “I learned the difference in preeclampsia and eclampsia.” Yet another stated, “I learned how difficult it can be to deliver a baby in the field.” Still another stated, “[I learned] the reasoning behind proper positioning of OB patients with abnormal presentations.” Finally, another student stated, “I learned during one of the three simulations the proper positioning of a patient displaying a pedal [Foot Presentation] delivery. It was obviously a situation that I was unsure about and the educational experience regarding the situation was great.”

In trauma care, there were a number of different comments. One student stated, “The instructor applauded our attempts to extricate the patient from the vehicle but also supplied suggestions at how it may have been done in a smoother manner and with less chance of risk with patient care.” Another stated, “I learned how to better make a tourniquet.” Still another stated, “[I learned] the importance of bleeding control early.” Yet another student stated,

I was most intrigued by the amputation case today and I learned ways to assist a patient who had been so critically injured after becoming entrapped by machinery. I know that although we discussed this type of case in class that I



would not have been able to treat this type of patient effectively without gaining the knowledge that I did in the SIM.

A few of the simulations involved medical-legal issues that the students may face in the field. Students didn't expect this type of simulation. One student stated,

The instructor was able to show that I had done everything I could have for my patient in question and that because of the laws pertaining to religious belief and our ability to intervene that I simply was not permitted to help the patient.

And another student stated,

During all of my clinical experiences I have never come across someone who refused medical treatment based on religious beliefs. I learned that while it was very difficult to walk away from a patient that appeared to need obvious medical assistance that I had to.

Finally a student stated when confronted with a do-not-resuscitate patient with absent paperwork, "I didn't have the paperwork and knew we had to start CPR on a terminal patient. But it was the wrong thing to do—but it was right—Argh! I was really frustrated." Perhaps the one of the best summaries of medical-legal issues can be found in a student's statement, "Calls involving advanced directives are a nightmare."

Many of the real-life EMS calls involve difficulty breathing. Within the scenarios students dealt with many different causes for difficulty breathing in both adult and pediatric simulated patients. One student stated "that I was not strong enough in my knowledge of the CPAP [Continuous Positive Airway Pressure] device to be able to utilize it properly." Regarding confusion on drugs and dosing in a respiratory scenario, a student stated "that I need to be more competent at pharmacology and drug dosing." One of the more disease-specific scenarios dealt with was congestive heart failure. A student stated, "I learned about CHF, and treatment options when dealing with CHF. I never understood this until we did it in sims."

There were a lot more comments by students about individual simulations that caused learning. I could easily fill another chapter with all of these comments; however, the greatest number focused on pediatrics, obstetrics, trauma, airway problems, and specific learning points from within individual simulations. Perhaps this student sums it up best, “I learned several alternative actions that should/could have been taken and that overall my actions/performance was satisfactory. My partner and I worked cohesively which produced a positive and effective outcome for our patient(s).”

### **What Students Say Caused the Learning**

Throughout the study, one of the questions asked was, What caused the learning? In years 3 and 4, I asked the students this direct question in the video exit interviews. I also asked this question in the year 4 evaluations at the end of each module in reference to that specific module experience. In addition, we asked the students to compare the learning to other learning methods such as lecture, laboratory, or live clinical experiences. This section is about the answers I got that were interesting and confirmed some of what I had already seen in previous years, but also revealed additional information I did not know.

### **Themes Repeated**

Many of the answers we were given regarding what caused their learning echoed themes that have been presented earlier in this document. Many students echoed the hands-on approach to learning favoring the psychomotor learner. Stated one student, “Well, basically in sims, I learned hands-on, I mean doing the stuff. And if I did it wrong, I got corrected and that was probably the biggest way. Learn from mistakes.” Another

stated, “The hands-on experience, just doing things helps seed it in your memory more.” Still another stated, “I learned this through the method of actually experiencing the issues.” Yet another stated, “Hands on working as a team and participating in the simulation” and from another, “I learned it by actually doing the talking and patient interaction.”

Many students gave very specific experiences that resulted in “hands-on” learning. One student stated,

The experience, getting to actually handle it versus being able to just tell somebody what to do. Like, um, the biggest thing would be like the prolapsed cord. That stands out to me in my head so much because I wasn't aware. I mean we had probably gone over it in lecture, but like I said, lecture is hard for me. I wasn't aware that you had to really pressure and keep it like that the whole way to the hospital on the cord. And that was something you had to do in there. So—and that's the challenge of knowing your hand, I didn't know that and I learned that here, so—Being hands on, definitely.

Another theme that students stated caused them to learn was the ability to watch themselves in the audiovisual recordings. Stated one student, “[I learned] by watching my teammates and their actions during the simulation.” Another stated, “I learned by watching myself on TV.” Still another stated, “I learned by watching my teammates. I saw things I didn't see as the leader on scene.” The use of audiovisual recordings allowed for deeper understanding of their actions and self-reflection.

Many students stated that debriefing in conjunction with other themes resulted in their learning. Stated one student, “Probably the feedback was the—obviously, you're sitting down to do debriefing with feedback was probably what helped me learn the most.” Another student stated,

It would've been a combination of everything you will put into practice and see that the stuff I learned actually does work. And then to go back through the recordings and say wow, I can't believe I did that, and then it all kind of flowed together to make the learning process easier. Yeah.

Still another stated, “Just the hands-on, doing and watching. Watching everybody, how everybody worked together, just actually doing. The debrief areas were areas that I could improve upon.”

One other theme that was stated was the ability to make mistakes and learn from them. One student stated, “Making mistakes, being in the situation of whatever you're at, whatever you're doing, making the call that you do, I guess. Mistakes is how I learned.” Another stated, “Well, basically in sims, I learned hands-on, I mean doing the stuff. And if I did it wrong, I got corrected and that was probably the biggest way. Learn from mistakes.” Still another stated,

How do I feel I learned? Making mistakes. I mean if you make a mistake in there [sim lab] and the mannequin goes dead on you, like you kill it, it's not a mistake you will make in the real world. And you learn just by doing stuff. The more you interact and do things, the more you'll learn, so that's what I like about it.

In summary, the most common repeated themes that students gave as the cause for their learning in simulation included the hands-on practical component, use of audio-video recordings, feedback during the facilitated debriefing, and the ability to make mistakes without harming others.

### Simulation Versus Lab, Lecture, and Clinical Learning

In years 3 and 4, I asked students to comment on how high-fidelity simulation compared to other classes such as lecture, skills laboratory, and clinical learning. One of the most common themes that emerged was that it reinforced or complemented learning from other sources. Stated one student,

It seemed like we would have an opportunity to see a particular diagnosis, treatment, you know whatever the case may be in the lecture setting, and then the very next week, Chet would throw it at us as a sim. So you get the activity portion. You sort of understand the concepts from a book standpoint, and then

Chet would put you in a situation where you had that patient or that diagnosis, and so then you have an opportunity to say okay, What do I recall from the lecture? What do I recall from the reading? Now, let's synthesize an appropriate field diagnosis, an appropriate treatment and sort of work it through to a logical conclusion.

There were a lot of comments from other students that reinforced the concept that lab, lecture and clinical experiences were all complemented by the simulation teaching methodology.

Another student stated,

I think of the three methods you just listed [Lab, Lecture and Clinical], the simulation in terms of the variety of scenarios I ran into was, by in large, the better experience. The clinicals themselves for the types of scenarios you ran into were obviously being a real life situation were the most beneficial in those specific situations but there were scenarios that went through in sims that I never saw in a clinical setting and likely wouldn't have seen in a clinical setting had I spent three times the number of hours in the clinicals. Two things, one the variety. The fact that folks running the sim could create a scenario that was a real life scenario but was something that I likely would not see just because of the frequency that those things exist or those—those things occur in—in the real world. And then having the opportunity to make mistakes and then go back into the follow-up debrief and talk about this is what you were thinking. Why are you thinking this? This might be another alternative in terms of the treatment. Um, you know, you missed the mark on the field diagnosis. And then not have those consequences be the way they would be in a normal real world setting, which is, you know, obviously a poor outcome for the patient or worse. It was as important, in my opinion, as the clinicals, and it was more important than the lecture. Um, again the—the—the—the thing that I look at or that I sort of use as a comparison when I'm looking at a lecture or clinicals and sims, I think sim is a hybrid of both lecture and clinical. You have the real world scenario. You get to play it out as if it were really taking place in a clinical setting, but then you [do] the follow-up debrief, which is, in essence, the lecture. You talk about the field diagnosis, the treatment, you know, everything you've got to do, so it's really an opportunity for the instructor to come into what is, in essence, a clinical setting and provide you with feedback and immediately on that particular scenario. You don't get that in a clinical setting because you don't have anybody there that's lecturing. I mean you get preceptors who will provide you with limited feedback, but it really is not a true lecturing scenario. And then conversely, in the lecture, there really is no clinical applications, no simulated—I mean, yes, there were some occasions where <instructor name removed> would like have us, you know, do a backboard. You know or talk about starting an IV or something like that. But to really have both of those

scenarios come together in terms of the learning style or the teaching styles, the only place that I truly saw it was in the sims.

#### A Fourth Form of Learning?

When asked how simulation learning compared to lab, lecture, or clinical experiences, they answered with a fourth category—experience. Stated one student, “I don’t think you can compare it to any of them [lab, lecture, or clinical]. It’s different, like oil and water—but better. It’s real, even though its safe, I mean you don’t hurt anyone but you learn.” In a similar sentiment, another student stated, “So, if I went by the book for all these sim calls, I’d probably freeze up and just suck at it. So, I think it’s a whole different perspective.” Another student stated, “For me, who has never been on an ambulance as a job . . . I went straight from basic [EMT] to [Para]medic [training], it gave me a sense of comfort on an ambulance versus just being thrown into it.” Yet another stated, “Well, I found it [simulations] more important because, like I said, it puts that perspective to people who maybe haven’t worked out in the field or who do work out in the field and you come across situations like this. Yeah, it made it important.” Some students describe the high-fidelity simulations as totally different from lab, lecture, or clinical learning.

#### Easy or Hard?

One of the questions I asked students was on the difficulty level of learning in the simulation environment. Was it easier than lab, lecture, or clinical experiences? Or was it harder? The results fell solidly into two camps with not many in the middle.

About a third felt the experience in the simulation lab was easier. One student stated,

Easier, “I think overall, they [sims] were probably easier. They were probably more stressful, but easier to actually do. It's something you're more or less doing it instead of trying to describe what you're doing. Do you know what I mean? You try and describe something to somebody and they may not be seeing the same picture as if you're trying to show them.

Another stated,

In terms of the anxiety level, and specifically during my clinicals, it was easier. It was less anxiety in the setting. In terms of knowing that there was going to be an immediate evaluation and feedback, there was some stress. I always took time over the weekends, because Mondays were the sim day, to make sure that whatever we had covered in lecture I knew. Like I would go back through it and be like okay, we just did PALS, Pediatric Advanced Life Support. I know Chet is going to give me a pediatric arrest, so literally like Sunday afternoon, I'm going through my PALS book like okay, let's talk about drug doses talk about treatments, talk about what's the defibrillation settings for a pediatric patient at this size and this size and this size. So from that standpoint, knowing that there was going to be immediate objective evaluation and feedback, that was—that was definitely something that was on my mind. But from an anxiety level, much, much nicer than clinicals. I've always pretty comfortable didactic learner. I never really had to put forth a whole lot of effort, so I would walk into any given lecture, even when we did ACLS and PALS and went on to ITLS, it was like I've read the material, I'm comfortable with it, this is a piece of cake. I mean, you know? I guess I might go along and not feel overly challenged.

About a third of the students found it easier overall than other formats.

There was only one student whose comments were closest to the middle (hard and easy). He stated,

Overall easier, though I guess it kind of depends. In the actually like practical aspect, it was harder because you're actually giving the meds and doing things and the—the patients are changing while you're doing procedures and by what you're doing. Like in the—in the classroom, you answer questions and you get it right or wrong, but here, you give them medication and you're responsible if something bad happens to the patient. So I'd say harder. I mean you have to be on your feet and if you get a wrong answer you're going to have, um, you're going to have a bad effect, whereas in the class, you get the wrong answer, you get the wrong answer. So, it's probably harder.

About two thirds of the students indicated the simulations were more difficult.

One student stated,

They [simulations] could be more challenging. Rarely were they easier. I would say for the most part, they were more challenging. It's not just the answers that you come up with that are right or wrong so to speak. You have to be able to act out the skills. You have to explain your thought process for a patient's care, um, the receiving facility you're going to take them to, and justify those actions versus answering a question on a test and it being right or wrong. You have to justify why.

Notice the critical thinking required in the simulations. In a similar way, another student stated,

Harder in the aspect that it makes you critically think on your feet and use the knowledge you have in a practical way versus just sitting in the classroom and talking about it and doing scenarios. There's no instructor here with you looking over your shoulder, pointing things out, stopping you to do this or that. It's like you're on your own and all you've got is your partner, which is—I mean that's how it is on the street. So it's like trial by fire.

Again, critical-thinking skills seem to be a theme that comes through. This next student combines the critical thinking elements with psychomotor skills:

They [sims] could be more challenging. Rarely were they easier. I would say for the most part, they were more challenging. It's not just the answers that you come up with that are right or wrong so to speak. You have to be able to act out the skills. You have to explain your thought process for a patient's care, um, the receiving facility you're going to take them to, and justify those actions versus answering a question on a test and it being right or wrong. You have to justify why.

In review, this section focused on what students say caused their learning; students stated they learned by having hands-on experience, watching the audiovisual feedback, listening to the facilitated debriefing, and learning from their mistakes. They also felt the simulation technology reinforced other learning modalities such as lecture, lab, or clinical experiences. Some suggested that it might be a fourth method of learning. When asked about the level of difficulty, the majority felt it was more difficult than any other single method.



## **Domains of Learning**

In EMS, the learning students are educated and evaluated using all three domains of learning (cognitive, psychomotor, and affective domain). Within the simulations, I began to see linkages to each learning domain based on the students' comments and actions. In this section, I will present the data based on the domains of learning that were observed.

### **Psychomotor Domain**

Psychomotor learning is that learning that involves physical or hands-on type skills and actions to achieve. Given the physical assessments, treatments, transportation, and other physical activities within simulation, it was no surprise that students overwhelming linked this style of learning to simulation. In support of this, one student described how they learned as,

Redundancy, hear it, say it, do it, and then the doing it part for me is, like I said I'm hands on, so I can read the book all day. I can sleep through the PowerPoints the best I can, but you're engaged. You're actively doing it and it just really cements it for me.

Another student who favored a psychomotor learning style stated,

I was a little more relaxed coming into the sims. In the classroom, I tend to get real stressed. But I wasn't as much in here [Sims]. I don't want to say that I engage this like a game-playing thing, but it was a role-playing thing, and I enjoy doing stuff like that. It's more fun than cracking open a book.

Still another student stated,

I think the real life portion of this, where you can go back and see how you did and learn from the mistakes or learn from the things that you have done well. I mean, book learning just isn't the same.

## Affective Domain

Affective domain is that learning that involves senses and emotions which cause learning to occur. One of the fascinating things the instructors involved in simulation witnessed prior to starting this study was very strong emotions on the part of the students participating in simulation. I shared in the context section how we saw students get into arguments in the back of the ambulance regarding treatments that would “kill” the patient. This was despite the fact that the patient was a manikin that mimicked but did not possess life. For students it was real.

Within this study, student emotions were witnessed at multiple levels. In one of the pediatric simulations, the actions of the crew resulted in the demise of the patient due to human error. Following that simulation, the team leader was found sitting on the bumper of the ambulance staring at the ground. He was physically and emotionally upset that his actions had killed a patient. We literally had to do a mini-psychological debriefing with him prior to entering the full debriefing with the team. There was no doubt in my mind that he was functioning in the affective domain.

In another simulation, the team must leave a pediatric patient who needs treatment because the mother has legally refused it on religious grounds. In one of those scenarios, the crew wanted the police officer to seize the child or arrest the mother so that they could treat him. This didn't occur. During the debriefing, tempers and emotions ran high as students felt this was wrong. Affective domain was definitely at play.

In previous statements written or stated by the students, emotions come through in their words. The section on realism shared a number of these. I will not repeat this; however, an earlier example sums it up,

Scary, very realistic, more realistic than I thought they could have done, quite frankly. . . . Like that peds sim [pediatric gunshot simulation], if you had GSW to the head, no exit wounds, this bleeding so it can get you—it can kind of get you pumped as you're going through it. Ugh, you're sweating and [arrgh sound as he looks up] and then you see yourself on camera later and you're like wow, I need to just breathe. So very realistic.

There is no doubt that the students' emotions are engaged in their learning activities within simulation.

Linked to the section I presented on reality, some of my fellow instructors and I feel that the realism that students describe in simulation may actually be an element or the cause of affective domain learning. Stated one student,

This gives me more real life feeling about the—ability to look back and see how I did. Um, it feels more—I'm able to retain it better, the information that I'm getting. We're learning in class and then coming here and being able to actually work it out helps a lot to retain the information. I think each type of learning method has their own benefit. I would say I think it's just as important. In some aspects it's more important. However the others are important too. I mean you can't go without the others. I think they're all combined equally important; however, the real life, this is here.

Here another student described their feelings,

Simulation felt like—ah, I felt stuck a little bit more just because it was hands on and it felt like you're treating real patients and not just saying what you were gonna do, but you were actually doing it. I'd say it was probably the same just because you can't go out and do this without the support of the other styles of learning.

Yet another student described how the near-reality of the simulation lab impacted their learning and confidence. I believe it is tied to affective domain.

I think the simulation is the closest thing I'm going to get to real—a real call other than begin out there. So it's—me personally, it's helped in my confidence in my skills. I've also seen other students from other programs and just their confidence levels versus the confidence levels with myself and the rest of my classmates, you can't even compare it. It's—it's amazing. I'd put it right up there as the same as, well, like being in the field, whether it's ER or riding the ambulance. I don't think it's any less or any more important than that, but definitely more important than lecture I would think. Me personally, I do better with hands on. You can teach me, just show me. Let me do it. Yup.

## Cognitive Learning

As I observed the students in the simulation laboratory and reviewed the many notes that they gave me, there was almost an aversion displayed towards cognitive learning, which was equated to lecture. Yet it was the cognitive learning that I witnessed them bring into the lab and then reinforce and expand the learned ideas. Critical thinking skills were a major component of every scenario that the students participated in. These skills were used to decide on the diagnosis, treatment plans, and other actions taken on the scene. It was very clear to me that cognitive learning occurred within the sim lab as well—especially during the facilitated debriefing.

I have already shared evidence of the cognitive learning in many of the other statements of the students. In addition, I would like to include these in that repertoire.

One student stated about their cognitive learning,

This was a lot more in depth. Uh, the instructors actually took time, not like instructors in the past haven't, but these instructors go in-depth into things. They explain it a little bit better and any question is going to get answered. I'd say it's about equal. I'm a hands-on learner. I mean I can sit and read a book all day long, and I can understand it, but to actually do it hands on is where I start learning everything.

I'm clear that this individual was learning both cognitively and through psychomotor. In another support of cognitive learning at play, a student stated, "You'd have to read stuff in books in order to try to get a grasp on it [EMS knowledge]. But when you do it hands on, that's where I, myself, learn." Essentially, this student was bringing their cognitive knowledge into the sim lab and then using it in application with psychomotor learning to reinforce the concepts. One last student illustrates the need for cognitive learning in their actions compared to "book" learning:

Just the fact that your thinking skills—I mean you're not sitting there, "Oh, man. Now I've got to find this page in this book," and to follow whatever it

says. You have to do it now. You've got to make up your mind quick and do it.

### A Combination of Three Learning Styles

In the past sections, I presented examples of how each domain was involved in learning within the simulations. When I heard this student's summation of learning styles in the exit interview, I began to realize that all three domains were at play within our sim lab.

Um—and that was the other thing when we talked to <staff member> with the differences between the three styles. I think the clinical simulation was the only opportunity to use all types of learning. I mean there was the hands on, you know, do as you're learning that way. There was the debrief process in terms of Chet being able to talk about—not necessarily this is the right answer, but this was the sim that I programmed, so you should've found this patient had COPD with exacerbation, or you should've found this was, you know, this type of an issue. This is what the field diagnosis that you should have come to, and then based on that, this is appropriate based on protocols and what the appropriate treatment is. So you had sort of this hands-on real world. You had a lecture style learning and then you had the benefit of the audiovisual because you had the initial dispatch information, which is him telling you this is what this patient information is. But then you have to sit down and debrief and you can actually observe yourself. PowerPoints are great in lecture and watching video and that sort of stuff, and certainly, in a clinical setting, hands on. But to [be] able to watch yourself perform the tasks in a—in a simulation, that—So all styles were going to get utilized which is—I've never seen that anywhere else in any other type of learning I've done. It's never been everything. It's either you're listening, you're being lectured to, you're taking notes, you're, you know, leading, you're hand-on, but nowhere have I experienced all of those facets of learning take place at the same time. Oh, yeah a ton.

Clearly, this student believed all three domains of learning were at play within their simulation experiences.

### What Students Say About Simulation Importance

As part of the simulation improvement process, I asked students what areas needed to be improved, and what was the most beneficial part of the simulation

experience. I also asked the question after each simulation module for year 4 students what they would change in the simulations. Within the simulations, there were no significant changes mentioned by students. Likewise, the instructors involved in observing or running these simulations were asked about recommend changes. Again, no major changes emerged. This would suggest that the simulations contained within the modules were well designed.

### Least Beneficial Parts of the Simulation Experience

I asked each cohort year what the least beneficial parts of the simulation experience were. With regard to years 1 and 2, I dealt at length with the problems that seemed to be inherent in the simulation process. In this section, I present the comments from years 3 and 4 of the study. Over three-fourths of the students surveyed answered they didn't know of any least beneficial parts. Two examples of these types of answers were, "I can't really think of one to be honest" or "I don't think there was a least beneficial part of it. I think it was all pretty good."

About a quarter had comments regarding individual concerns. The greatest number of these students voiced concerns over being a Medical First Responder team member. Stated one student,

I'd probably say being—I'd say probably the MFR portion of it just because we have to, I mean, basically go backwards from what we'd been trying to do, so it was probably the most—that was probably the most difficult and least beneficial portion.

Another student stated,

Yeah, I would say in the fact that we had to switch gears. We basically had to take the medic side of things and turn that off and just do the basic stuff. But, I mean, you're sitting there going, 'You know, I need to do this, but I can't because I'm MFR.'

Still another voiced frustration in any role except the team leader. They stated,

Hmmm, the least beneficial part of the simulation experience? I don't—I don't want to be like petty or anything, but the—I think the thing that was least beneficial to me was having to share lead medic role with the other members of my sim team. So, you know, any given sim day, we're doing two or three primary simulations, and in the interest of everybody learning, you've got to share that lead. But really for me, the most learning took place from when I was the lead paramedic, and then subsequently, a little less learning as the medic partner, and then a little less learning as MFR lead, or quite frankly no learning as a basic, you know, MFR. Because I would walk in and I would immediately have to remind myself you're an MFR. Don't work beyond your level or licensure. You know, you can take the blood pressure. You can get a sample history, and then all those things are important and I totally embrace the—the sort of mindset of if you have a good ALS—the ALS side, it doesn't mean good, but the BLS skills are where I felt like somehow that it was like almost a waste of my time to like reiterate this is how to take a blood pressure and this is how you get a sample history, and this is—not that I don't think those are important, but from a learning standpoint, having to—like today. I had a great day, great sims. I wasn't lead medic once. So my learning, in my opinion, was less than would have been had I been the lead on all those sims.

A couple of students voiced concerns over some the occasional technical difficulties. Stated one, “Dealing with technical difficulties.” Within the simulations, there were occasional times where the manikin failed to function properly. Examples of this were a cephalic OB delivery where the birthing motor froze and a traumatic limb that failed to maintain spurting arterial blood. While both issues decreased the fidelity of the simulation, they did not cause it to stop; however, modifications such as orally telling the students that it is still spurting had to be used or detaching the baby and pulling it the rest of the way through the vaginal opening were required.

Two other students voiced concerns over time and paperwork. One stated, “The amount of time. Yeah, it just put more of a strain on my already limited amount of availability.” The other stated, “Paperwork. I guess I actually looked at as I already do paperwork because I work in the field already, so it didn't really help to learn to do any

more better because I already have my own method of doing it. So it was kind of just repetitive for me, I guess.”

### Value of Simulations

In the exit interviews, students were asked to rate the value of simulations against other learning technologies, with an awareness given to them that it was one of the most expensive learning environments to create and use. This was one of the few questions where the viewpoints were quite unified. One student stated,

As a student, I know for a fact that I am better prepared, both from a – a scholastic standpoint in terms of being able to successfully complete, you know, the various tasks that will be in front of me in terms of completing the program, obtaining the national registry, begin getting licensed, but also I'm better equipped to go out and provide care as a paramedic because of the clinical sims, than somebody who did not have this experience. And so in looking at the cost benefit ratio, absolutely it exists here and anybody that questions that has not spent time observing the sim and doesn't understand they help people learn really what it's like to work in EMS—learning EMS and to go out and function in EMS.

Another stated,

You try being a student without it. That's what I would say to them. Try to be a student without it because that would be almost impossible to get your competencies in anything because those things aren't common in the field and they want you to be aware of it. Um, and on top of that, when you use lecture and put it together, it like sticks in your head. It makes it so you don't have a doubt in your mind that you are doing something correct. You know what I mean? And you have blood pressures and stuff to prove it, and vitals, and that's all stuff that you wouldn't get if you didn't have a sim lab.

Still another stated,

I absolutely think it's necessary to my learning. I feel that it's benefitted me in many ways. I don't personally know the financial budget nor what was spent on the element, but it seems like an appropriate use of the funds for what I got out of it. . . . I feel as if I have a little background and am a little more comfortable in a real life call simply from the simulations I've had and some that were similar to real life calls that I've had thus far.

Yet another student stated,



I would say it's definitely a good way to spend the money. I mean I can see why it's expensive, but it's such an experience. It's such a hands on experience. I ran calls on clinicals that I had similar calls to what I've done in sims and I just felt more prepared, and I think it's a great way to learn, and I think everybody should have it for their program because this helps you with things that you're not going to see in the field. I think it's very important.

Building experiences were voiced by this student,

I would definitely say or have them compare the students that are going through it and the students that aren't and seeing the difference in the field because we have a ton of experiences that people that aren't going through it didn't. Oh, definitely. I think it helped a ton in my assessment skills.

The sense of realism was reconfirmed in this student's comment,

Not having—I mean, when you look at the cost, the most expensive thing is obviously the building, but that's already here, but then the high-fidelity mannequins are probably the next greatest cost. Could we still do it without them? Yeah, but it wouldn't feel nearly as real. It wouldn't be like treating a real patient. It would—I think not having the mannequins and a lot of the tools and stuff that we do, it would take away from the realism and the learning experience, honestly.

Safety and learning were voiced by this student's comments, "One of the greatest benefits of simulation is making mistakes and learning how not to make them again in the future." Finally, in pulling together the larger picture, this student stated,

I'm a hand on learner, so it's very important for me to actually do things in order to really learn it. . . . I've been an EMT for a while, so I'm—you know I think that a lot of EMS is street experience, you know, your index of suspicion, your patient's care, communication, and personal skills are communication skills. So I think that this is very important. I mean obviously, we did a lot in clinicals too, which I think is just—probably more important because they're, you know, you're interacting with real people. But I think that this is important because this puts you in situations that, as Chet calls them, sentinel events that we don't experience often in the field. So like today, we ran a pediatric gunshot wound. I hope I never have to run that call and in 16 years of EMS I've never run anything close to that call. So, this is important because you learn how to deal with the situations, in a situation where there's no penalty. If you don't treat them right the first time, you can look back on it. You can reflect on it, and hopefully in the future, when we do run calls like that, we'll be better prepared. So as far as street experience, I think that it's comparative and for those students who are coming in stronger with not much street experience because it gives them exposure to the stresses of an actual

scene, which they do a great job of that with Julie being other characters on scene in the sim lab, but also you give people with experienced exposure to calls that some people never experience in their career. . . . I think that it's important.

### A Model for EMS Education

A number of students voiced concerns that this should be required as part of the education experience for all EMS professionals. In comparing programs with simulation and without, one student stated,

I think it's absolutely beneficial. I think you can see the difference between programs that have it and programs that don't. If you're going to make a mistake, this would be the place to do it, not in the real world.

Another perhaps summed up best many of the students' thoughts:

My comments would just be this is something that we, as an EMS industry, should require this type of learning opportunity because having now spent a certain number of hours with other individuals who have done paramedic programs either in the recent past or currently at other educational institutions, I mean to compare my knowledge, my comfort level, and my ability to function in that setting to theirs, both in terms of my personal observations and in terms of what the—the preceptors tell me about students from other programs, there's no comparison. You know, the students coming out of this program are students that are impressing preceptors, whether it be in a hospital or on the ALS rigs. So my comment would be for those people wanting to take advantage of this technology, either as students or as educational institutions, you're making a mistake and you're hurting EMS as an industry, and the patients that we treat.

## CHAPTER 7

### CONCLUSIONS AND RECOMMENDATIONS

Within Chapter 7, I discuss the conclusions and implications of my study. I approach this by dividing this into four distinct subsections. First, I present the emergent themes that came from data described in Chapters 4 and 5. Second, I answer the sub-questions that were presented in Chapter 3. Third, I provide a model that can help answer the overarching research question. Fourth, I answer the overarching research question of how paramedic students learn in a high-fidelity healthcare simulation environment. I also discuss the limitations and delimitations of this study. Finally, I discuss the conclusions and recommendations for this research.

#### **Emergent Themes**

##### Introduction

Emergent themes are those themes that emerged as I conducted this research over the 4-year period of time. They summarize the conclusions and lessons learned in providing this simulation experience to paramedic students. They are organized and titled by the overall concepts that emerged as a result of the collected data and repeated experiences from the learners in this study. They include all of the data collected in this study.

## Context Is Vital

Within the first year, it became all too evident that context was extremely important in this study. The lessons learned in context led to the creation of Chapter 4 that discussed the process of getting the context correct. I couldn't collect legitimate accurate data until I started years 3 and 4 due to context. It was during year 2 that I actually got the context corrected enough to collect meaningful and accurate data.

In preparation for year 1, I spent a great deal of time reviewing the existing literature on simulation so that I could use it educating EMS practitioners. While this review helped in many ways, it failed to adequately prepare us for what we would encounter. I toured many simulation labs across the country and reviewed what other practitioners were doing in different fields; however, EMS functions differently. EMS workers encounter calls in a different setting, then move to their ambulance, then move again to the hospital setting. Communication technologies include portable radios, cell phones, land-line telephones, and more. Everything they use must be portable including the manikins. "Wired" technologies are not as effective in this environment: Wireless is the mode operation. There are few hospital simulations that start on a factory floor, living room, or outside in a vehicle. In short, the simulation context in EMS can be quite different from traditional simulation laboratories. It took our experiences in year 1 to refine and learn this lesson.

Some of the greatest context lessons learned in this study included (a) establishing the simulation procedures, processes, and equipment that were conducive to learning; (b) decreasing "down" or non-productive time for students; (c) learning as educators about what we didn't know that we didn't know—this was often a trial-and-error process; (d)

understanding what and how the students were learning in simulation; (e) establishing how many students can effectively participate in a simulation and in what roles; (f) acquiring and adapting EMS patient technologies for simulation; and (g) learning that EMS simulation is often different from simulation performed in traditional simulation centers.

Part of my context plan had to include flexibility and the ability to quickly change. I wrote a section titled *Down the Rabbit Hole* which describes how students will select the direction they plan to go whether it is right or wrong. The context created must allow for these choices in real time. I learned that stopping a simulation to change the environmental simulator was devastating to the student learning experience. It broke suspension of disbelief for many students, resulting in less realistic experiences and learning. I have discussed and given evidence for this in the *Realism* section.

Context was vital to this study. Had I attempted to answer the study questions at the end of year 1, my answers would have been very different from ones presented after conducting the study for 3 more years. It wasn't until we as a group survived working through the context learning in year 1 that we were actually very effective in years 2-4. Context is a vital component in simulation.

### We Often Don't Know What We Don't Know

*We often don't know what we don't know:* Besides context, this has been one of the strongest themes throughout this study. Over and over, I saw this theme repeat not only in the simulations with students, but also with the educators. In year 1, the sim operators had at least as high a learning curve as the students did in simulation, perhaps even more. We really didn't know what we didn't know; this included using simulation

technologies, best sim procedures, best debriefing techniques, the right questions to ask in a debriefing, features needed that were vital in the manikins, and more; however, we learned and changed the context so that students could learn more efficiently. We (the instructors) continued to learn in each of the following years as well, though the learning curve did flatten somewhat.

I discuss this theme more in the sections *We Don't Know What We Don't Know (Part 1)* and *We Don't Know What We Don't Know (Part 2)* with examples from the study. One of the students summed it up best when he stated,

We sometimes don't realize what we do on a scene, or do well on a scene. The video is good constructive criticism. I think that you can improve if you see yourself in action, and then you can improve from there.

Clearly, he is learning what he didn't know about his actions.

In learning what they didn't know, students would complete a simulation and often express that they “rocked” or did an excellent job; however, in analyzing their actual achievement, it would be quite substandard. They didn't have a clue what they didn't know—what they had misdiagnosed. Still others would enter the debriefing thinking they totally screwed up the call, only to find that their actions were closer to the mark than they ever thought. Throughout all of this, I realized that students often don't know what they don't know.

In year 1, we were puzzled at how students could often be presented with a very clear change in the patient's condition and not see it. Likewise, conditions would change on a scene that we could obviously see; however, the students were totally oblivious to it. We knew we were seeing something, and we could even describe it fairly well—so could the students. But we didn't know what it was caused by nor what it related to. In short, we didn't know what we didn't know. But we did learn what it was through research and

a little luck. In the *Situational Awareness (Perceptual Awareness)* and *Sustained Inattention Blindness* sections, I go into the more specific details and answers for this.

### Learning From Mistakes

A close companion to *knowing what we don't know* is *learning from mistakes*. In and of itself, simply knowing what you do not know doesn't necessary change your behavior when confronted with a similar problem. We saw this in simulations where a student repeated the same error not learning from the first occurrence. To learn from those mistakes by changing behaviors or actions is actually completing Kolb's Learning cycle or Schön's reflective practice in learning. Perhaps in support of this concept, one of our students in the study said it best, "One of the greatest benefits of simulation is making mistakes and learning how not to make them again in the future."

Within this study, the learning that occurred both in the instructors and students was too abundant to discuss in its entirety here—rather, I will point out some specific examples of how that concept applied. If you want to see the multitude of errors committed, please read the *Observed Errors* section and all subsections under it. I could easily write examples of the learning that occurred from each of these errors.

As a specific example of learning from errors by instructors, I will present an error we experienced in year 1 of this study. In that year, we designed an obstetrics simulation so that the students could experience a childbirth delivery in the pre-hospital setting. The manikin lacked a human voice possessing a number of automatic prerecorded responses from the manufacturer. Unfortunately, in a true human dialog between practitioner and patient, the questions asked will far exceed those that can be answered in prerecorded speech; such was the case in our simulation scenario. We

quickly learned that despite the best designs and prompts, including a live person who would speak for the manikin in the room, the best solution was to give the manikin a voice, where answers could be given “on the fly” as practitioners asked them. We ended up implanting a walkie-talkie in the manikin and using that until the manufacturer developed a similar implanted technology. We learned from our mistake in year 1 and fixed it. Eventually, even the manufacturer learned from the same mistake and fixed it as well. Now if they only could make the lips move with the speech.

In another specific example, I discussed how students pick the rabbit hole they will go down. We learned this lesson after attempting to design scenarios where they were forced down one rabbit hole—changing the size of the specific rabbit hole we wanted them to pick into a size that an elephant could easily manage. It didn’t matter, they would often choose the most random, small and remote hole that was possible: We couldn’t even imagine they would (though a different lesson, we learned that we couldn’t predict what students would do—only guess at the probabilities). An example of this was already presented in the *We Don’t Know What We Don’t Know (Part 2)* section. In that example, the student used adenosine instead of albuterol in a respiratory distress scenario, totally catching us (the sim instructors) by surprise during one scenario. Luckily, I knew how to quickly reprogram the manikin simulator so that we could follow that student down the wrong rabbit hole. We (sim instructors) had already learned this skill and had backup plans for how to follow a student down a rabbit hole. We had learned that lesson!

When we first started doing the simulations, we were appalled at the number of mistakes that were made. There were many conversations amongst the instructors, “What were our students learning? Was instruction that bad? What was going through their



head?” As time passed, we began to realize that this was how they learned not to make that mistake again. Instead of seeing this as a bad measure of instructional performance, we began to see it for what it really was, the ability to learn. Often, when I first mentor a new instructor in simulation, they will recognize the errors their students make as reflective on them and evidence of bad instruction; however, I have realized that, in fact, that isn't necessarily true. Students don't know what they don't know and need a mechanism to discover it, and then learn from it to change their behavior. Simulation provides that unique mechanism.

#### Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs

At the beginning of this study, when I developed the study sub-questions, I asked, “How does the audiovisual feedback in debriefing influence the student?” After completing 4 years of data, I now realize that the audiovisual feedback is half of an important marriage within the debriefing; the other half consists of the facilitated feedback. This is probably the next most important theme following *We Don't Know What We Don't Know* and *Learning From Mistakes*. It's not just important that students learn from their mistakes, but it's important that they learn the right actions as well. The facilitator in a debriefing serves a vital role in making sure the correct actions are learned using positive learning techniques.

I will discuss the specific advantages of the video evidence within my answer to sub-question 5. In short, the video feedback provides solid evidence of student actions within simulation; however, it lacks the reason why that action was taken. It is that part where the right questions from the facilitator change the learning from a simulation.

Open-ended questions are a major advantage to understanding why an action was taken. In a sense, it is understanding the students' thinking process on how they got to that decision. Once understood, looking at the results of that action and potential consequences can help the student create new concepts and plans, if confronted with a similar situation. In a sense, the facilitator debriefer is changing the thought process of the student, often without the student even being aware it is being done. As an example of this, one student stated,

I know that the sims lab is meant to be a positive learning environment and I definitely appreciate the “kudos” I receive when I do something right. . . . The instructor did an awesome job at leading the students to accepting responsibility for their personal actions without the students even realizing it was happening. I was surprised at the students' belief that they “got the job done” even after watching the video played back. I could see, though, that they were taking in what the instructor was pointing out and in some I could see signs of recognition in their faces as they had an “a-ha” moment. The students seemed to be quite laid back and at times quite jovial—I know as a participant of the debriefing process that this behavior does help to alleviate some of the stress and/or frustration experienced during the sim. I was presently pleased at the ability of the students to quickly process the treatment that would be given when considering the components that had been missed. In hindsight, this was a positive way to address the faux pas that had occurred.

The students' actions were corrected but in a non-threatening way that allowed them to learn rather than becoming defensive and combative about their actions.

In conducting the debriefing, the lack of facilitation can result in the wrong lesson being learned. Within one debriefing, I recall when I asked a student why she put oxygen on the patient; her answer was, “Because that's what I've seen other responders do.” When I further asked, “But why is that done?” Her answer was, “I don't know?” There was a clear disconnect between what was done and why it was being done, despite the fact it was the correct action in this scenario. While it's difficult to harm someone with oxygen therapy, there are instances where it has happened. The more important concern

here is the lack of knowledge for why this action was taken. That lack of understanding can be deadly in other situations, as seen within the many errors I've presented in the Chapter 6 sections on errors. Applying oxygen to a cyanotic patient with respirations of 6 won't help fix the underlying volume problem. The use of bag-valve-mask will, perhaps with oxygen attached to it.

Another example of learning the wrong lesson involves the electronic patient monitor that novice paramedics use (or don't use). In early simulations, we noticed a pattern where the monitor was not used until late in a scenario to gather information about the patient. When asked why, students had a number of different excuses; however, the underlying fact was that those excuses were invalid. Even though this was stressed in the briefing, it would often take several team leads before a student would actually get the monitor on early in a simulation. Despite the lack of a monitor contributing to a recognition of a situational awareness change during their simulation, students had still not learned the correct lesson. Once this lesson was learned, they became quite adapt at having a partner attach a monitor to the patient in about a minute while they got a report. As they repeated future simulations, they learned how helpful that simple action would become—further reinforcing its use.

From my observations of 4 years of simulation and debriefs, I believe that the bulk of the learning probably occurs as a result of the debrief using facilitated debriefing with audiovisual feedback. The simulation serves as a methodology to identify the things that are unknown to the student and reinforces those things they know. It is the debriefing that gives them the true understanding of why their actions were wrong and what correct actions can be taken in the future. If they take those actions, they have learned or change

behavior as a result. Reflection by the learner occurs both during the debriefing and afterward. The key measure to whether or not correct action is learned is whether or not it is performed when given another chance, such as a future simulation, to demonstrate that they can do it correctly.

There are a number of effective strategies and actions that a good facilitator/debriefer can use to help improve learning. Among them are to establish that the actions they are going to take are not harmful or punitive to the student. The learner must feel safe about being wrong among their peers and others. This is very hard for most individuals. When students become defensive about their actions, they often fail to hear or understand the reasons for the errors. If the student feels berated or abused, they may learn the wrong lessons. I discuss more of this in the next theme, *Learners Must Have a Safe Learning Environment*.

In summary, the facilitated debriefing is where the bulk of the learning occurs. The use of audiovisual feedback coupled with facilitated debriefing provides the evidence of actions along with the correct information on how to correct it. Video doesn't lie, but it also doesn't provide the reasons for one's actions. It is through facilitated debriefing that a full understanding for all occurs including what changes are needed to learn from one's actions.

### Learners Must Have a Safe Learning Environment

In discussing the safe learning environment, there are two major reasons that this has become a major theme within this study. The first involves the need, which I touched on within the above section, *Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs*. The second is actually both an ethical and practical reason

which I will discuss below; however, it falls under the medical concept of *doing no further harm to the patient*.

In the previous section, I discussed how having a safe learning environment was critical for effective learning. One of the lessons we as debriefers learned within this study was that for it to be effective, students could not be defensive. If they were, rather than a learning experience, it became an us-versus-them conflict. In that scenario, the goal is to have a winner and a loser and depending on what side you were on, you would want to be the winner. In reality, the purpose of the sims has nothing to do with winning or losing—or perhaps everything depending how you look at it. If the students learn from their mistakes, everyone wins due to improved patient care. Both students and debriefers had to approach the debriefing in a non-confrontational way with the understanding that it's okay to make an error, it's okay to be wrong. That requires a safe learning environment.

At the beginning of each simulation module, there is a short briefing that uses a short PowerPoint presentation. In that PowerPoint presentation, there are two slides that are always at the end. Figure 10 shows the slide on confidentiality. To maintain a safe learning environment, students must realize that they can't discuss observed errors of other students outside the sim lab. Likewise, students are always reminded about the purpose of the simulations by Figure 11.

The simulation environment is discussed at length within the *Introduction to Simulation* presentation so that students understand what is expected of them. The instructors need to set clear expectations on how they are to conduct themselves and each other in this environment. In the first year, we had some minor violations of this policy

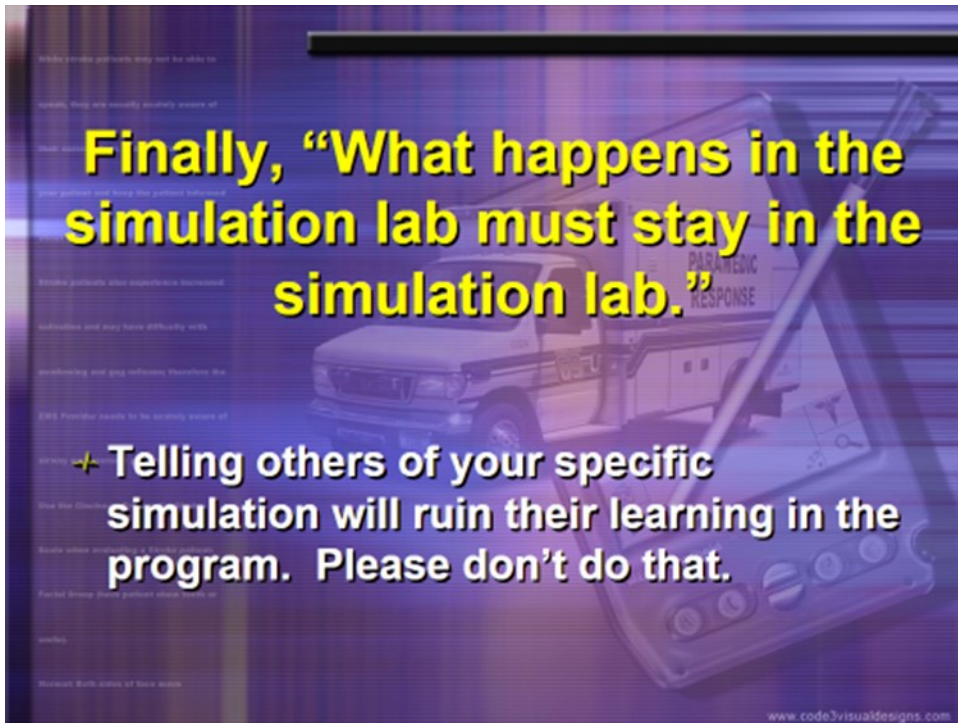


Figure 10. Slide on confidentiality.

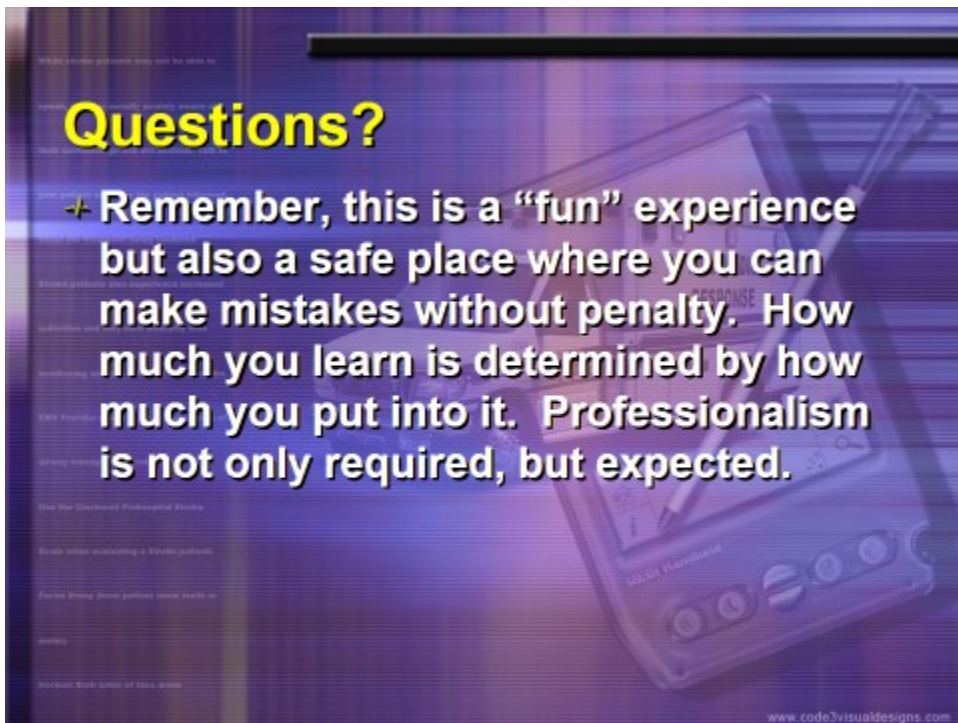


Figure 11. Safe learning environment slide.

because I didn't express the expectations clearly enough. In years 2 through 4, the violations were almost non-existent. Students did an excellent job of conducting themselves with integrity and discipline—perhaps because they were often reminded that they could be the next one who makes that major mistake.

Besides establishing the safe learning environment for the purposes of confidentiality and effective simulations, there is a deeper reason for the safe learning environment—that of simulation itself and its impact on field practice. In the current education model for paramedics, the goal of the educational process is to prepare the learners for safe practice as a paramedic. As part of this model, students are exposed to lecture in which didactic and affective knowledge is taught, laboratory practice where psychomotor skills and affective knowledge are taught, and the clinical environment where students acquire a knowledge bank of experiences observing treatments and applying their skills on live patients. Outside of the classroom, if mistakes are made by the paramedic student, they will involve live patients where the results could be lethal. Simulation provides an environment where they can practice what they learn using all other methods *prior* to practicing on live patients.

Simulation also provides a place where experiences can be gained in a more controlled environment, guaranteeing that similar experiences are learned by each student, not just those who were lucky enough to see them in a clinical setting. By definition, sentinel events are often infrequent in nature, yet the practice preparing for these events is nearly absent in the training. The knowledge base is discussed and tested in these areas but the actual application in the practice of a sentinel event rarely occurs.

Simulation provides a mechanism to do just that so that the first encounter with these events can be a learning experience without the costs of a human life or injury thereof.

In the sections on errors, I provided page after page of specific errors that were committed by the students in simulations. Most of these errors were repeated by many students. This section was compiled primarily from the data of 31 students in 173 simulations and did not include every mistake, only the top ones in each category. Imagine if these weren't done and learned in simulation? Instead, they might be learned in the field, during practice on live patients. In medicine, one of the first laws is to do no further harm to a patient. The establishment and use of a safe learning environment using simulation is consistent with this law. The lack of simulation use in the education of practitioners can be considered contradictory to this law.

In summary, simulation can provide a safe learning environment for students to learn what they don't know, practice and reinforce what they do know, and practice new knowledge so as to reduce practitioner-based injuries to patients in the field. The instructor must first establish this safe learning environment and then monitor and maintain it. Students must have clear expectations on what this safe learning environment consists of and maintain it before, during, and after all simulation experiences.

### Learning Lessons From Other Industries

Too often, a profession becomes so engrossed and concentrated in its specific knowledge base and content that it fails to look outside of the profession for new knowledge. In some ways, I have been guilty of this. I have also seen parallels to this in EMS as well. This study would not have been possible had I not looked outside of the content of EMS and into what had appeared to be a non-related industry such as the



airline transportation industry. It was there that I learned many of the debriefing techniques and CRM concepts that I would share with my students in this simulation project. It is also there that I see a lesson to EMS as an industry.

Within this dissertation, when I first started reviewing high-fidelity simulation, I learned that other medical professions were conducting simulations using high-fidelity manikins such as the Meti Human Patient and Harvey Simulators. I viewed high-fidelity simulations within hospital-based simulation centers and realized that EMS was still placing a high-fidelity manikin in the middle of the classroom, expecting this to be equivalent; it wasn't. It wasn't until I saw how anesthesia was mimicking a real operating room experience complete with anesthesia machine, patient table, and high-fidelity manikin that I realized how important environmental simulation could be. About that same time, we created our first ambulance simulator for a Laerdal Sim Man manikin. As I described in my context section, we began a journey that produced this 4-year study. While we did a number of unique and inventive things, it was because we looked outside the EMS industry that we realized the potential.

The Kohn et al. (2000) study, *To Err Is Human*, mentions looking at parallel industries such as the airline transportation industry. My research into CRM and simulation from that industry was pivotal in what we did within this research. The debriefing techniques, scenario structure, teamwork, simulation methods, and more all directly related to learning from this parallel industry.

It is interesting that EMS has actually been in the midst of manikin development throughout its brief history. One of the reasons for purchasing the Laerdal Sim Man was its use in the teaching of resuscitation to students; however, in the past few years, I have

also observed how pockets of EMS training have incorporated simulation training into the preparation of EMS practitioners while the rest remain oblivious. In some ways, I feel as if the industry has lost the edge it once possessed in this area. As an industry, EMS needs to keep a watchful eye on other related and unrelated industries, since the changes there can often be a remedy for problems within EMS.

Every now and then, throughout this study, we had what I would describe as unique moments of wonder. In years 3 and 4, when we allowed students to watch us in the control room, they remarked on the teamwork and precise actions they saw the instructors take within that setting. I realized that they were watching us follow many of the sterile cockpit rules a pilot goes through when flying an aircraft. Each of us had our roles and responsibilities but also we used cross-monitoring functions. Each knew what the other was doing and we would assist each other as needed. We had a checklist we followed for starting the simulation. It paralleled many of the aviation models' practices—yet it was EMS simulation. We had learned from a parallel industry.

My summary on this item would be that we need to be vigilant and aware of the learning within other industries whether they be directly related (such as nursing, anesthesia, etc.) or unrelated (such as airline transportation, nuclear industry, or others). Often the solutions to problems faced within those industries may solve similar problems within EMS. In this case, much of the high-fidelity simulation processes and CRM have direct application to EMS.

### Teaching Leadership Challenges for Paramedics

One of the elements or non-technical skills that was taught to paramedics in this study was that of Leadership. Per their job description and laws, paramedics are often the

highest emergency medical personnel on a scene. As a result, they are required to assume overall leadership for the management of the patient. Leadership is a skill that requires practice. Simulation is an effective methodology to teach the skills of leadership since the combination of facilitated feedback coupled with audiovisual evidence allows the learner to see exactly how they function as a leader.

In a sense, our methodology for teaching leadership is much like that of throwing a child into a pool to learn how to sink or swim. Following a very short discussion on leadership within the Introductory Simulation Module, students are thrown into the simulation to practice their skills, following a lucky (or unlucky) roll of the dice. They quickly learn to sink or swim, and the feedback mechanism in simulation aids in their understanding of actions. As a leader, they must be proficient in communication, delegation, command and control, planning, responsibility, situational awareness, critical thinking, teamwork, and stress management. Tools such as CRM and TeamSTEPPS can be beneficial as aids to help them develop practices that are conducive to leadership. Avoiding pitfalls such as tunnel vision, sustained inattention blindness, subversion, errors in judgment, and more can all be practiced within simulations.

The use of audiovisual-facilitated debriefing is extremely effective in learning leadership. One student commented on their first team leadership experience,

I learned that I really didn't have a clue. As I watched the video, I could see how truly dumbfounded I was because I was standing back doing nothing—kind of scratching my head since I wasn't sure what to do.

In this case, the student didn't enter the scene with a plan in mind. They quickly learned the mistake in that leadership action and learned not to repeat it. This same student would later excel at team leadership following a number of successful team leads.

In my experience teaching leadership to students, simulation is one of the most effective learning methodologies that can be used to teach this ability.

### **Sub-Question Answers**

To answer the overarching question of how paramedic students learn in a high-fidelity simulation program, seven sub-questions were developed. The answers for these questions come from the data acquired in Chapters 4 through 6. The following sections were developed to answer each of these questions.

#### Sub-question 1: Student Description High-Fidelity Simulation

Sub-question 1 specifically asked, “How do students describe high-fidelity healthcare simulation instruction?” In Chapter 6, I presented the students’ own words to help answer this question. Here is a brief summary of what they said.

In the *Realism* section, students described the learning environment as very realistic. Stated one student,

Scary, very realistic, more realistic than I thought they could have done, quite frankly. There were some scenarios where things were coming at us and I'm like, you know, and the mannequins in particular. I mean you're able to listen to breath sounds, take a blood pressure, run a 12 lead, and to really be able to assess a mannequin and get true vitals and truly be able to say muffled R-tones and there's absent breath sounds, tension pneumo [pneumothorax], you know, reactive pupils, and then they have extra piece of having Chet and Julie communicate as the mannequin, through the mannequin speak in response to your questions or agonal breathing or altered responses. That was—they were incredibly realistic, like scary sometimes. Like that peds sim [pediatric gunshot simulation], if you had GSW to the head, no exit wounds, this bleeding so it can get you—it can kind of get you pumped as you're going through it. Ugh, you're sweating and [arrgh sound as he looks up] and then you see yourself on camera later and you're like wow, I need to just breathe. So very realistic.

Most students found their experiences extremely realistic resulting in *suspension of disbelief*.

In addition to realism, students commented within the realism section on the fact that in this environment they made the decisions. There was no instructor telling them what to do or attempting to move them in a particular direction. One student stated,

In here [simulations], it's like there's no direction. It's up to you to make the decisions . . .—it's part of the learning process. You're making decisions in the simulations based on knowledge you've learned through reading and instruction in the classroom labs. You're using the skills in the back of the ambulance and, um, you—and it gives you a sense of responsibility if you can let yourself get drawn into simulation, if you let yourself get drawn into it as though it were a real live call.

In the *Easy or Hard?* section, a student further commented,

It [Simulation] makes you critically think on your feet and use the knowledge you have in a practical way versus just sitting in the classroom and talking about it and doing scenarios. There's no instructor here with you looking over your shoulder, pointing things out, stopping you to do this or that. It's like you're on your own and all you've got is your partner, which is—I mean that's how it is on the street. So it's like trial by fire.

Students appreciate the ability to autonomously practice their knowledge base, discovering what they do and don't actually know.

In the *Controlled Environment* section, students appreciated a place where they could experience calls that they either didn't see or were responsible for in the clinical environment. A student stated, "The fact that you actually get to use the actual teachings in a controlled environment versus using it on the street where anything can go wrong." In this environment, we can duplicate those calls that often result in sentinel events or where the specific correct actions of the paramedic will make a difference to outcome of a patient. We can expose them to calls where the number of clinical experiences are low and unreliable. This environment allows us to repeat similar calls so that students can identify what they don't know and turn these into proper practice.

In the section titled, *A Safe Place to Make Mistakes*, I describe how the students appreciate the ability to have a safe learning environment where they can make mistakes without the risk of harm to another human being. Stated one student, “It was pretty close to the clinicals or the clinical experiences, just if we messed up, it wasn't as big of a deal. It didn't have a negative impact on somebody's life.” Another stated, “It gave us an opportunity to use our skills and what we've learned in the classroom, apply it and if we messed up something really bad, you know, we weren't killing somebody. I mean we were, but we weren't.”

In the *Themes Repeated* section, I shared how students appreciate the ability to make mistakes and learn from them. As an example, one student stated,

How do I feel I learned? Making mistakes. I mean if you make a mistake in there [sim lab] and the mannequin goes dead on you, like you kill it, it's not a mistake you will make in the real world. And you learn just by doing stuff. The more you interact and do things, the more you'll learn, so that's what I like about it.

In a different example, students expressed their appreciation for learning the correct knowledge within a debriefing. In an example of “hands-on” learning, one student stated,

The experience, getting to actually handle it versus being able to just tell somebody what to do. Like, um, the biggest thing would be like the prolapsed cord. That stands out to me in my head so much because I wasn't aware. I mean we had probably gone over it in lecture, but like I said, lecture is hard for me. I wasn't aware that you had to really pressure and keep it like that the whole way to the hospital on the cord. And that was something you had to do in there. So—and that's the change of knowing your hand, I didn't know that and I learned that here, so—Being hands on, definitely.

In the *Learned Leadership* sections, I discussed how students appreciated a place to lead prior to entering into their clinical internship. One student stated,

Here [in the sim lab], we learned how to lead before we did it in our Internship. The video showed me stuff I didn't see as a team leader. Frankly, I

wouldn't have believed some of it if I didn't see it with my own eyes the second time. I don't know anywhere else that is doing this.

Yet another stated in an email to me,

I have been involved with four saves since I received my medic. Two out of the four went or will be going home...I've been in charge of 2 of those cardiac arrests. The one was a complete save. I believe he will be going home soon...The sim lab has a lot to do with how I run my calls and how I can keep a level head. Without out that, I don't think I would have the success that I've had since becoming a medic.

Leadership is a difficult set of skills that needs to be practiced to achieve competency in it. Students appreciate the practical application of this skill within the simulation lab.

In summary, the simulation laboratory is a realistic setting that mimics what is found in the clinical setting. It provides a safe place to make mistakes, and learn from them, without potentially compromising a human life. It's a setting that allows students to make autonomous decisions including the practice of leadership. The simulation laboratory provides a controlled environment to allow for less common experiences or the uniformity of experiences between students to be known.

#### Sub-question 2: Augmentation of Clinical Experiences

In sub-question 2, I asked; How do high-fidelity healthcare simulations augment clinical experiences for paramedic students? In year 1, my study focused on the use of audiovisual instructor-facilitated feedback and its impact on student learning within the simulation process. As discussed in the context section, I was also focused on fixing the various elements of the context. What I didn't know was how effective simulation was to complement the clinical experiences for our students. As we started year 2, we began to realize that the students were having experiences within our simulation laboratory that were either complementing or replacing experiences they were lacking within the "live"

clinical component of their training. Patterns in their comments and the data collected all suggested that their clinical learning was being affected by what we were doing in the simulation laboratory. It led to the creation of this sub-question.

In the section, *Simulation Comparison to Traditional Clinicals*, I presented some of the data that answer this question. There are a number of ways that simulation augments clinical experiences in the education of paramedic students. These include (a) providing uniform simulation experiences that mimic the quality of clinical experiences when done under the proper context; (b) providing the less common clinical experiences; (c) providing a time-efficient method for achieving deficit competencies; (d) providing a potentially better method of observing specific skills, (e) providing quantified measures of skills performed; and (f) providing a safe environment where committed errors can be learned from without harm to humans. I will discuss each of this in the following paragraphs.

In the section *Problem of Uniform Experiences*, I discussed how in the 500 hours of clinical experiences, the actual clinical experiences each paramedic will receive are individualistic and can vary widely—resulting in non-uniformity in the clinical experiences they receive. As a result, there are often gaps in or a lack of certain experiences for students. While the solution of increasing the required clinical hours may improve the odds of experiencing some of these missing experiences, even a three-fold increase in hours cannot guarantee acquisition of a deficit experience. Simulation provides an avenue by which those experiences can be acquired in a uniform way so that every paramedic student is exposed to the same baseline experience.



Students found the simulated clinical experiences at least equivalent to those found in the “live” clinical setting; however, they recognized that they did not see many of the simulated clinical experiences during their live setting. More importantly, within the simulated experiences, they were not merely observers; but rather, they were active participants totally responsible for the assessment, diagnosis, and management of the simulated patient. The feedback they received strengthened their safe autonomous practice by allowing them to learn from mistakes. For that reason, many students saw the simulated experiences superior to those in the “live” clinical setting.

Simulation provides a methodology for exposing students to uncommon experiences—also referred to as sentinel events. Some of these less common events may be experienced by the paramedic within their career. Unfortunately, the lack of clinical exposure to these experiences does not adequately prepare the paramedic for their first “live” encounter with that situation as a practitioner. In the section *Experiencing the Uncommon Clinical Experiences*, students appreciated that simulation-based experiences allowed them to experience both the common and less common field experiences. One student stated,

It gave me an opportunity to see things that are uncommon that you might see in your career, and that's probably the biggest thing about the sim lab . . . you see things that you wouldn't normally see and that you need to know how to handle.

Again, within the simulated experience, students were responsible for the overall assessment, diagnosis, and management of the patient. They weren't viewers but were, instead, active participants. That isn't true of all clinical experiences. Another student stated,

I think of the three methods you just listed [Lab, Lecture and Clinical], the simulation in terms of the variety of scenarios I ran into was, by in large, the

better experience. The clinicals themselves for the types of scenarios you ran into were obviously being a real life situation were the most beneficial in those specific situations but there were scenarios that went through in sims that I never saw in a clinical setting and likely wouldn't have seen in a clinical setting had I spent three times the number of hours in the clinicals. Two things, one the variety. The fact that folks running the sim could create a scenario that was a real life scenario but was something that I likely would not see just because of the frequency that those things exist or those—those things occur in—in the real world. And then having the opportunity to make mistakes and then go back into the follow-up debrief and talk about this is what you were thinking. . . . I think sim is a hybrid of both lecture and clinical. You have the real world scenario. You get to play it out as if it were really taking place in a clinical setting, but then you do the follow-up debrief, which is, in essence, the lecture. You talk about the field diagnosis, the treatment, you know, everything you've got to do, so it's really an opportunity for the instructor to come into what is, in essence, a clinical setting and provide you with feedback and immediately on that particular scenario. You don't get that in a clinical setting because you don't have anybody there that's lecturing. I mean you get preceptors who will provide you with limited feedback, but it really is not a true lecturing scenario. And then conversely, in the lecture, there really is no clinical applications, no simulated—I mean, yes, there were some occasions where <instructor name removed> would like have us, you know, do a backboard. You know or talk about starting an IV or something like that. But to really have both of those scenarios come together in terms of the learning style or the teaching styles, the only place that I truly saw it was in the sims.

Simulations allow paramedic students to experience the less common clinical experiences in a uniform manner.

Clinicals are a time-efficient method for accomplishing clinical competencies. In *Time Spent Versus Experiences Gained and Competencies Achieved Through Simulation*, I showed how clinical competencies achieved in simulation were actually more time efficient than in their counterpart “live” setting. In situations where a student is missing competencies due to a lack of clinical availability, this study demonstrated that simulation can provide a very time-efficient alternative method at filling this gap. This can be accomplished without lengthening clinical hours for a student.

The simulation experience may allow for better observation of specific skills practiced than in the clinical setting. Within the debriefs with students, as they reviewed their performance of a skill on video, they would often comment about how they saw mistakes in their actions. During the time they performed the skills, one to three instructors would be monitoring their actions from the control room. If the student didn't catch the error, one of the instructors would, and it became part of the debriefing discussion. Both instructors and students realized that watching skills on video could often show mistakes that were not caught in the clinical practice of those same skills. In addition, the timeline for when and how long a skill took to perform was exact within the simulation experience since video recordings showed the specific starting and ending point of a skill. If oxygen therapy was indicated early within a scenario, there was no denying that it took 10 minutes before the first oxygen delivery occurred within a scenario; likewise, there was no denying that it took 1 minute 34 seconds to apply the device from start to finish.

The performance of skills in simulation often provides quantitative measures that are unavailable in the clinical setting. The high-fidelity manikins report back to the operator very quantitative measures of the air they received from ventilations, rate of ventilations, rate of CPR compressions, depth of compressions, location of compressions, and more. These measures are not available from live patients and are estimated based on chest rise, pulse during compressions, etc. For novice paramedic students, this was critical information for improving their practice during a simulation. As seen within the qualitative *Observed Errors* section of this study, there were numerous errors made that were involved with quantitative measures such as ventilation depth, rate, intubation

depth, etc. On a live patient, many of these errors can only be suspected, but are more difficult to confirm to the 100% confidence level. Using simulation technology, the errors are readily measured and easily observed, leaving no doubt about what has occurred.

Students commented that in the simulated environment, there was often better feedback experienced. In the section *Objective Evaluation of Skills*, one student stated,

It [simulation] gave an opportunity to physically do the things that I was going to be doing as a paramedic, to use the critical thinking skills that I was developing as a paramedic student, and then to have somebody immediately evaluate, and then not have the subjective evaluation. It would be an objective evaluation. The one thing that I did get more so with ALS agencies, less so with the hospital setting, but I got some evaluation at the end of the clinical or at the end of a particular run, but it tended to be subjective evaluation the medic would make through offhand comments about well, I think he did this or I don't know if he said that to the patient, I'm not really sure if he understood. In this setting, you've got the audio, you've got the cameras, you've got Chet and Julie actively involved in the sim, so when we go to the debrief, it's very objective. They're able to say this is what you were doing. This is what you said you were doing. Now, tell me why and what was the intent and that sort of stuff, so that in that objective what you got was huge.

The students often commented on how their skills were closely monitored in simulation. The major section *Observed Errors* gives examples of how specific the observations were regarding individual errors. Often the use of the pan-tilt-zoom camera was monumental in being able to watch closely a particular skill or verify that a step had been done. Having the verification on video for use in the debriefing was equally useful for students since it identified the specific mistake or correct action.

In the qualitative *Observed Errors* section, I discussed the numerous errors that were observed within the simulations. These errors were committed by paramedic students in autonomous practice of their craft during realistic simulations. The results of many of these errors would have been additional injury or death to the patients they were treating; however, due to this occurring within the simulation lab, no harm resulted. As a

result of these errors in the sim lab, during the debriefing, correct actions were identified and learning likely resulted. It is unknown if the same learning would have resulted from clinical (or later) autonomous field practice errors. What is known is that during a number of the debriefings, students were totally oblivious to the fatal mistakes they often made. The instructors often speculated on how many of these errors went undetected in the real world (whether it be during student clinical experiences or in later actual practice). What is clear is that simulations with audiovisual-facilitated feedback provide a safe learning place for students to engage in their first autonomous practice without endangering humans in the consequences.

In summary, simulation technology acted as an excellent augmentation to traditional clinical experiences for paramedic students in this study. The data showed that the use of simulation contributed to more uniformity of experiences, served as an avenue for less common clinical experiences, was a time-efficient method for achieving deficit competencies, served as a potentially better method for observing specific skills including the use of more quantified measures, and provided a safe environment where errors are a source of learning without harm to humans. Simulation is a partnership for traditional clinical experiences.

### Sub-question 3: Facilitator/Debriefing in High-Fidelity Simulation

In sub-question 3, I asked, How does the facilitator/debriefer assist the paramedic in learning within a high-fidelity simulation environment? Throughout my qualitative data section, I gave numerous examples that answer this question especially within the *Instructor-Facilitated Feedback* section. In short, the facilitator/debriefer creates a safe learning environment, helps learners identify what they didn't know and reinforces

knowledge of what they do know, helps participants identify correct responses to their errors, and promotes learner reflection. Students often identify the debriefing as the most important part of the simulation experience due to the learning that takes place.

In the learning theme *Learners Must Have a Safe Learning Environment*, I discuss in length the importance of establishing a safe learning environment. The actions of the debriefer are paramount to establishing and maintaining this setting. For students to learn, they must know that what they share and do within the simulation lab remains in that setting and cannot be used to harm them. The facilitator/debriefer must use debriefing techniques and terminology that do not violate this concept. This gives the student permission to make mistakes—especially in this setting.

One of the most important actions the facilitator/debriefer can do is to identify both the correct and incorrect actions that were taken by the students within the simulation. When they encounter correct actions, this can be reinforced by showing the action (here audiovisual recording shines), allowing the student to state why it was the right action, and then confirming that they are correct. This simple sequence allows students to confirm what they know. The debriefer plays a major role in doing this.

Often the students don't know what they don't know, as I pointed out in the sections with similar titles (parts 1 and 2). In these instances, the facilitator/debriefer must gently direct the students to the fact that they made an error. One of the easiest ways to do this is often to go back when the student made the decision and have them explain why they did what they did? What was their thinking process? By knowing this, the facilitator/debriefer can then help them to seek alternative pathways in future behavior.

One of the most important actions a facilitator/debriefer takes is to make sure students understand the correct actions when an error is encountered. If this is not done, the student may learn the wrong lesson and when confronted with a similar problem take equally wrong actions. Knowing the correct actions when making an error allows students to learn the correct behavior and thus reinforce it quicker in future simulations.

One of the other important tasks that the facilitator/debriefer must perform during the debriefing is to enable and promote reflection on the part of the learner. This reflection often occurs during the debriefing, but in some cases it may also occur following the debriefing. The use of open-ended questions and allowing students to think through a process allows for them to start this reflection process. Allowing them to get to the correct answer can be tedious; however, in doing so they often learn the concept or deviation in their critical thinking pathway better. The facilitator/debriefer plays a key role in doing this.

During the debriefing, it is important that the debriefer focuses on the incorrect action and avoids casting the person or team as wrong. By focusing on the actions, they are less likely to induce a defensive reaction by the team or individual. This results in both maintaining a safe learning environment and increasing the overall effectiveness of the debriefing.

Students suggest that the bulk of the learning in simulations occurs as a result of the debriefing. Of course, this learning can be fundamentally attributed to a facilitator/debriefer creating the right atmosphere and asking the right questions. From the section *Facilitated Debriefing Produces Learning*, one student stated, “Without

instructor feedback, I would not have even realized the small areas that could be improved upon.” Another stated,

The debrief is probably the most important part. I mean we noticed or I noticed mistakes made during the simulation, but it's the debrief where you catch a lot of things and will have a lot of things pointed out, and I think that has the biggest impact on the learning.

Still another stated from the section *We Don't Know What We Don't Know (Part 2)*, “I did not learn any of this until we did the debriefing, didn't realize that I was doing these things until the debriefing.”

In summary, the facilitator/debriefer plays a vital role in helping students learn from simulation experiences. Their actions include: creating a safe learning environment, helping learners identify what they don't know, reinforcing knowledge of what they do know, helping participants identify correct actions in response to their errors, and promoting learner reflection. I agree with the students that the debriefing is where the bulk of the learning takes place. The role of the debriefer in creating an atmosphere where learning can take place is paramount to success within the simulation experience.

#### Sub-question 4: Simulation Environment in HFS

In sub-question 4 I asked, How does the simulation environment contribute to student learning? The answers to this question comprise a major portion of this study. The short answer is that the simulation environment has the following contributions to learning:

1. It provides a realistic controlled environment where students can learn without the potential of harming a human.



2. It provides a place for the practice of paramedic competencies including those that are more difficult to obtain within their clinical experiences. It may provide better feedback mechanism in the evaluation of those competencies.

3. It allows all students to practice less common clinical experiences uniformly so that the overall clinical experiences for a paramedic are well rounded.

4. It allows students to practice sentinel events.

5. It allows for autonomous independent student decisions in the management and care of patients for greater assessment of their abilities.

6. It allows students to know that which they didn't know in their knowledge.

7. It allows for the practice of real-world calls in a safe learning environment without harm to patients.

8. It provides an objective evaluation of skills and knowledge.

9. It reinforces learned knowledge to the students while identifying knowledge gaps.

10. It allows for the specific practice of assessment, leadership, treatments, planning, evaluation, communications, and teamwork.

11. It allows the students to apply and learn within all three domains of learning (cognitive, psychomotor, and affective).

12. It ferrets out errors in practice and provides an organized mechanism for learning the correct actions.

Each of the items on this list has been covered throughout this dissertation especially within Chapters 6 and 7.

### Sub-question 5: Audiovisual Feedback

In sub-question 5 I asked, How does the facilitated audiovisual feedback in debriefing influence the student learning? I provided a number of the answers in the data section *Student's View of Audiovideo Use* and the theme *Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs*. Within the theme, I discussed how after 4 years of study, we realized that the audiovisual recordings were an inseparable marriage within this study. The short answer was that the audiovisual recordings provided the evidence of students' actions within simulation; however, it did not provide the reasons for those actions. It is the combination of the two, facilitated debriefing with audiovisual feedback, that combined result in student learning.

The use of audiovisual recording was less of an issue to students learning to become practitioners than I expected, based on comments from previous studies. In fact, in analyzing the pre-simulation surveys, the majority (77%) felt it didn't bother them (29%) or they actually like it (48%). No one expressed a desire not to be recorded.

Many students suggested that the use of audiovisual recordings allowed them to see another viewpoint. Stated one student,

[I learned] . . . well through the audiovisual feedback especially. You can see what you did right. You can see what you did wrong. You can learn things about yourself, especially emotionally speaking, how you act on scene, how other people view you, as a leader or as a partner. You can determine where you fit in in team dynamics.

Students see their actions in recordings and there is no hiding from what was done. The viewing of these actions acts as a stepping-off point in the debriefing, allowing the facilitator/debriefer to ask the important question about why they took that action.

A common leadership problem is the development of tunnel vision in which because of task saturation, the leader often overlooks or is unaware of a major situation.

The audiovisual recordings allow that leader to see the “big picture” on the screen including the actions of others that were un-noticed. One student stated, “I heard <student name> tell me the patient’s respiratory rate on the scene, but in the sim I never heard her say that. The debrief [video] showed it though . . . twice. I guess I’ll pay more attention next time to the MFR [Medical First Responder].” In this case, the student failed to correct an underlying respiratory rate of 6 in an unconscious patient due to tunnel vision.

Within the debriefings, the audiovisual recordings serve as a source for students to know what they didn’t know about their actions or others around them. Within debriefs, I have often replayed a clip multiple times so that students can view it and discover the error themselves. If they discover it, they are more likely to remember it.

One student stated,

The instructor-mediated feedback helps provide a visual so that you can better identify with the constructive criticism you may receive about your performance. If the visual portion wasn’t there, students might not remember or “see” what things they are doing that they may not even be aware of.

Another student stated,

We sometimes don’t realize what we do on a scene, or do well on a scene. The video is good constructive criticism. I think that you can improve if you see yourself in action, and then you can improve from there.

The use of audiovisual recordings allows students to visualize and “relive” parts of the simulation experience, seeing it from a different viewpoint.

While the audiovisual recordings allow for identification of student actions, they do not explain it. For this, the facilitator/debriefer must engage in Socratic questioning to pull out of the students the reasons for their actions. I discuss more on this in the theme *Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs*.

In summary, both the audiovisual feedback and facilitated debriefing methods work together to allow the student to learn. The audiovisual recordings provide an alternate viewpoint or "big picture" that allows them to see their actions (correct or incorrect) for further discussion. By viewing the audiovisual recording and using follow-up questioning on those actions, the facilitator/debriefer can help the student identify errors as well as potential alternate responses.

#### Sub-question 6: Leadership Skills

In sub-question 6 I asked, How does the simulation experience develop leadership skills? The answer to this question draws on the data presented within Chapter 6. In the section *A Safe Place to Make Mistakes*, I used medical errors as the source for student comments about the importance of having a safe place to make mistakes; however, this also applies to leadership errors—perhaps even more. You could easily substitute the leadership errors from the *Leadership Errors* section in place of those medical errors. Because of the simulation environment, no humans were harmed in committing these leadership mistakes; however, students did learn from the experiences in applying those lessons to their future actions where consequences matter. We saw evidence of that learning within the simulations when they changed their leadership methods based on previous simulation experiences and learning. In their exit interview, one student remarked,

Here [in the sim lab], we learned how to lead before we did it in our Internship. The video showed me stuff I didn't see as a team leader. Frankly, I wouldn't have believed some of it if I didn't see it with my own eyes the second time. I don't know anywhere else that is doing this.

Simulation serves as a safe practice ground for making and learning from leadership errors.

In the section *Tunnel Vision*, I described how students didn't gain situational awareness until they saw their simulation from a different vantage point. Situational awareness can be a difficult skill to master—especially for those leaders who become too closely engaged in specific tasks. The simulations allow those students to see those situations from a different perspective to help identify their own behaviors that may be interfering with situational awareness.

In the *Learned Leadership* section, I present the evidence of those specific leadership skills that were learned within the simulation process as team leaders. This included: responsibility, learning teamwork, mastering command and control, strategies for acquiring situational awareness, avoidance of sustained inattention blindness, the importance of planning, dealing with stress, and in communicating to all those around them. Within the simulations, gaps in the student knowledge within these leadership skills are identified and then corrected so that they are better able to lead.

Finally, to lead a team, the leader must know what it is to be a good follower. Because they must work in both the roles of leader and follower within the simulations, they learn what it is to be an effective follower. While there is a direct connection to Goleman's Emotional Intelligence model here, good leaders being aware of their team member follower abilities can result in more effective leadership during a call or simulation. For followers, there is a right time and method to correcting a leadership error. This too is learned as part of the simulation process.

In summary, the simulation experiences developed leadership skills by providing a safe place from mistakes to learn, while allowing for the practice of leadership skills. Well-crafted scenarios allow for students to make mistakes that can identify gaps in their

leadership knowledge and skills. The use of facilitated debriefing allowed a method of learning from those mistakes. By participating as both a leader and a follower, a better understanding of the leadership role is understood by the learner.

#### Sub-question 7: Simulation Learning

In sub-question 7 I asked, What kind of learning is healthcare simulation uniquely designed to provide? This sub-question wasn't added to the study until later, due to our learning of what we did not know about simulation technology—more specifically its relationship with errors. When we first started doing the simulations, we noticed a significant number of errors that were occurring in each simulation. The *Observed Errors* section—that includes sub-sections *Reason's Classification*, *Active Errors*, and *Specific Errors*—contains 42 pages of errors that were observed in the study. What isn't documented is how often some of these errors were committed. At first, we began to question the quality of initial instruction that was occurring within the program; however, as time went on, we realized that the errors weren't an indication of the quality of instruction, but rather, a measure of how effective the simulation process was at ferreting out errors and then using them as a learning method. This unique ability of simulation was something new in education—something worth highlighting and sharing with others; thus, this sub-question was developed.

In my investigation and follow-up to some of the errors listed in the sections above, I investigated the quality and instructional material that was presented in the classroom. The evidence from this review of covered materials suggested that students had indeed been exposed to the correct methods in the didactic classroom teaching, written textbook readings, and practical skills labs. We also learned that not all students

made the same mistakes. Each learner seemed to make different errors, and while some commonalities did exist, the bulk of the errors occurred at different times as different specific errors by different students. There was no specific pattern that we could see. In reviewing who made specific errors, we would find both higher performing and lower performing students committing the errors. The only commonality we found was that when the student had significant field experience, they were less likely to make some of the error types. This research led me to ask the question, “Why are these errors being committed?” I began to realize the answer with the help of my co-instructor.

The answer comes in several parts. First, each student has different knowledge gaps in their learning of material. This knowledge was part of what led us to the concept that students often didn't know what they didn't know. This was true whether they achieved high or low academic scores in their overall studies. Second, the simulations we constructed were very good at providing the freedom (or autonomous practice) for students to make these errors. In a sense, these simulations ferreted out these knowledge gaps that were easily detected in their incorrect actions. Third, the use of facilitated debriefing with audiovisual recordings provided a methodology for the student to identify their mistake and then seek alternative actions that could have been taken. This was part of the reflective process in the debriefings. Learning was verified when these alternate actions were applied and seen by the instructors in future simulations by the student. This answer is part of the foundation of a simulation model I will present in the next section.

One of the verifications of the above process was in the comments of the students that I have provided in the previous sections *A Safe Place to Make Mistakes, We Don't Know What We Don't Know* (all parts), *Facilitated Debriefing Produces Learning*,

*Quality and Direction of Debriefings, What Students Say They Learned, What Students Say Caused the Learning* (especially the sub-section *A Fourth Form of Learning*), and *Domains of Learning*. I will provide two quotes that highlight what I am presenting here. The first I shared in the sub-section *A Fourth Form of Learning* from a student, “I don’t think you can compare it to any of them [lab, lecture, or clinical]. It’s different, like oil and water—but better. It’s real, even though its safe, I mean you don’t hurt anyone but you learn.” In this statement, the student clearly stated that they believed the simulation experience was different from the traditional classroom or clinical experiences. The second quote comes from a student during their exit interview,

And then having the opportunity to make mistakes and then go back into the follow-up debrief and talk about this is what you were thinking. . . . I think sim is a hybrid of both lecture and clinical. You have the real world scenario. You get to play it out as if it were really taking place in a clinical setting, but then you follow up with the debrief, which is, in essence, the lecture. You talk about the field diagnosis, the treatment, you know, everything you've got to do, so it's really an opportunity for the instructor to come into what is, in essence, a clinical setting and provide you with feedback and immediately on that particular scenario. You don't get that in a clinical setting because you don't have anybody there that's lecturing. I mean you get preceptors who will provide you with limited feedback, but it really is not a true lecturing scenario. And then conversely, in the lecture, there really is no clinical applications, no simulated—I mean, yes, there were some occasions where <instructor name removed> would like have us, you know, do a backboard. You know or talk about starting an IV or something like that. But to really have both of those scenarios come together in terms of the learning style or the teaching styles, the only place that I truly saw it was in the sims.

Both of the these preceding quotes suggest that simulation is unique from lecture, lab, or clinical experiences. It is a new process that turns the commitment of errors into a safe method of learning.

In summary, simulation provides a unique methodology to safely learn from errors committed as a result of knowledge gaps within individual learning. Unlike the clinical setting, where the learning from these same errors can occur at a much higher



cost (human life or injury), simulation provides this experience without risk. In this way, it is unique from the learning processes found in the lecture, skills lab, or clinical settings.

### **Simulation Learning Model**

As I completed the data collection and analysis process, I began to realize that the learning I was seeing was in many ways systematic from simulation. While the observed errors varied differently from student to student, the process by which they learned followed a pathway. It was from this realization that I constructed the model shown in Figure 12. This is closely related to Kolb's (1983, 2001) experiential learning theory. This model describes the process that simulation uses change behavior as a result of learning. I will describe this model in each of the following subsections.

#### **Learner Pre-Existing Knowledge**

Prior to the simulation experience, the learner has acquired knowledge regarding the simulation they are about to participate in. This preexisting knowledge was learned from the classroom studies including laboratory skills (psychomotor), classroom lecture (didactic), previous experiences working, observations in clinicals, evaluations, and more. All of these combined to create a known body of knowledge that is unique to that student; however, there may be gaps in that knowledge that are known or unknown as they enter the simulation environment.

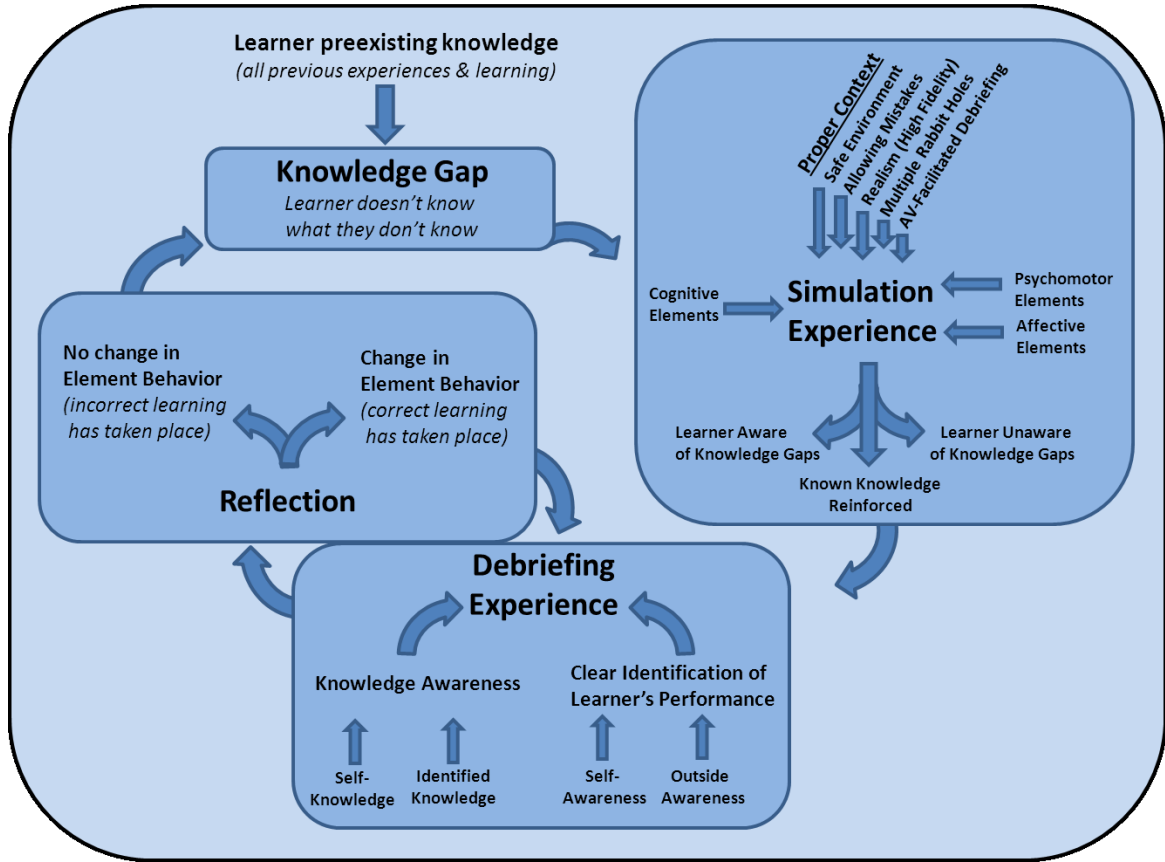


Figure 12. Dalski learning model.

### Knowledge Gap

Prior to entering simulations, students may have a combination of known and unknown knowledge gaps. The known knowledge gaps often involve the lack of practice as a practitioner and involve knowing how to put the individual elements that they've learned into a seamless structure that can be used in a complete call. Unknown knowledge gaps are those the student practitioner doesn't know that they have. I described this concept in the previous sections *We Don't Know What We Don't Know* (Part 1) and *We Often Don't Know What We Don't Know*. Regardless of the cause, known or unknown, it is at this point that they enter the simulation experience.

## Simulation Experience

In the simulation experience, cognitive, psychomotor, and affective domain elements are injected into the simulation. In this study, this included Leadership, Teamwork, Communications, Assessment, Diagnosis, Treatment, Safe Practice, Situational Awareness, and more. These elements were the constructs of the simulation.

In addition, the context must be correct for success in simulation. Factors that create the proper context include: maintaining a safe learning environment, allowing the students to make mistakes without correction until the debrief, providing high-fidelity so as to establish realism above the level of disbelief, allowing the inclusion of multiple “rabbit holes” for the students to potentially jump through, and using facilitated audio-visually recorded debriefings. All of these I have described in earlier sections of this study.

Within the simulations, I indicated earlier in the errors section that the students did more right than wrong in most simulations. Because of this, in the simulations, the majority of actions taken were correct in nature. During the simulations, in response to those actions, the debriefer marks on the video timeline those correct actions for discussion and reinforcement in debriefing. In this way, knowledge that was known by the student is confirmed and reinforced so that the student will continue to engage in that practice.

In almost all simulations, errors were committed. These ranged from minor errors to major life-threatening errors, including those that ended in full cardiac arrest of the patient. An important feature of the simulations is that the student must be allowed to make mistakes. I describe this more in the section *Down the Rabbit Hole*. There were two

different student responses to the errors. The first response was knowledge that the error had been committed. In this case, the student was looking for the reason behind why the error was committed so that they could change future behavior. The second response involved total oblivion to any errors committed. In fact, some of the most difficult debriefs were when the crew felt they had really done a great job when, in fact, the opposite was true. In any event, all three of these conditions (awareness of knowledge gaps, unawareness of knowledge gaps, and known knowledge reinforced) proceed to the debriefing segment for further discussion.

### Debriefing Experience

In the debriefing experience, one of the first determinations that needs to be made by the debriefer is a clear identification of the learner's performance. The use of audio-video recording is an excellent method for capturing this. Its strengths are that it clearly shows the actions that were taken (assuming the camera is in the right position); however, the weakness is that it doesn't explain why that action was taken or how it was decided. This requires additional assessment.

Once the exact action is isolated and confirmed, the question becomes, What is the exact awareness level of the student? Open-ended questions help, such as "Why did you do this?" or "What were your thoughts when this occurred?" This Socratic questioning method identifies the frame of mind that led to the action of the student. This can be a slow process, but spending the time can be invaluable.

In debriefings during year 1, in some simulations, I made the mistake of assuming why the student made a mistake then following it with the recommended change in practice. That is a flawed method since the answer to why something is done can only be

answered by the person who does it. By following this incorrect procedures, the debriefer never gets to the root problem that caused the misstep in the first place. In other words, they treat the symptoms rather than the underlying disease. This often led to no change in the student's future performance when confronted with a similar problem.

Within debriefing, one of the greatest lessons I have learned is how important the debriefer can be in this learning process. I discussed this in my section *Facilitated Debriefing With Audiovisual Feedback Is Where Correct Learning Occurs*. When students don't know why they were wrong in their actions, they may change their actions to a different wrong reaction to the same problem. Knowing the correct action to change to improves the learning and allows for repeated practice of the correct lesson. The facilitated debriefing is critical to this process.

### Reflection

At some point either during the debriefing or shortly thereafter, the student enters into a reflective period examining what they did and the consequence of it. In some cases, this reflection will acknowledge the things the student did well that were positively reinforced by the debriefer; and thus, reinforce the repetition of that behavior. They may also see how their actions resulted in untoward outcomes for the patient. Here, two choices confront the student: Do I change my behavior the next time I see this or do I ignore what occurred hoping for a better outcome the next time it occurs? If the student selects the first option, they will change their response or behavior the next time they are confronted with the situation. Learning has occurred as a result. This change is likely linked to information supplied during the debriefing by the debriefer. If they choose to

ignore this element, repeating their response to the same situation, no learning has occurred and likely the outcome will be the same.

I have observed there are two different and unique times that reflection occurs within the simulation cycle. The first is during the debriefing; this is during the time the identified behavior or action is ferreted out and alternative pathways are discovered that could potentially lead to other and better actions in the future; however, the second actually occurs following the entire debriefing and is separate from the debriefing. That reflection is often quite deep and promotes changes as well. It is for that reason that in Figure 12 I showed the arrow both connecting facilitation to the debriefing but separate as well.

For example, I have observed how some paramedic students will enter the simulations with a very bold attitude, suggesting that they will make no mistakes or errors in the course of their leadership experience; however, in the course of their actual simulation, many mistakes are made—often major in nature. While it's a humbling experience, I've had several of these individuals talk to me at later times to discuss their actual mistakes. In some cases it is to look for absolution, in other cases it is to try to reconfirm where they went wrong. It is clear to me that some reflection occurs following the simulations long after they've left the lab.

It is also clear to me that student practitioners often see more in the audiovisual than I point out during the debriefing, such as their actions. Some students have discussed with me their actions in the simulation that both I and my co-instructor didn't notice. It is clear to me that they are actively reflecting on those observations by this action.

## Re-entry Into Knowledge Gap

Upon completing their reflection, students will then reenter this loop again. If they are confronted with a similar set of elements that cause previous failures, hopefully they have chosen a correct pathway in their behavioral change. If so, they will achieve success on this element, thus reinforcing their actions regarding this element in the future. If not, it may require a new analysis and action plan in the future loops. In this form, the process repeats itself.

## Summary

The Simulation Learning Model suggests a mechanism that explains the learning observed within this study. Its constructs are based on the research and data accumulated and analyzed within this study and best represents how students learned within this simulation environment. It starts with the premise that novice practitioners often don't know what they don't know and ends with reflective practice-based learning, similar to what Schön (1983, 1987) identified as a positive attribute in education of medical practitioners.

## **Overarching Research Question Answer**

The overarching research question is, What and how do paramedic students learn in a high-fidelity healthcare simulation program that includes audiovisual and instructor-facilitated feedback? As seen by the data, themes, and answers to the research sub-questions, there are multiple answers for this question—depending on the learner and context; however, I have constructed a model that I think explains the answer to this overarching question. My answer will align itself with the model.

I would start my answer with one of the themes my research revealed, *We Often Don't Know What We Don't Know*. Students enter the simulation with prior knowledge they have gained through their classroom work and previous related life experiences. While they often know a lot, they lack knowing what they don't know. They don't know their own pitfalls and the potential flaws in their application of this knowledge. In essence, unknown to them, they have a knowledge gap. They are primed to learn through application of their knowledge and experiences but lacking the opportunity. It is at this point the simulation experience excels.

Paramedic student practitioners enter into the simulation experience with all of these learned cognitive, psychomotor, and affective knowledge bits that they have acquired. To be effective, the simulation must be constructed in such a way as to test their application of those bits of information. Because the simulation environment can be made to mimic the actual “live” practice environment, students are often unaware that they are being tested. For them, it is an application of their learning—showing what they can do. They are immersed in a false reality with a safety net.

During the simulation, students make a multitude of decisions. The majority of times, most of the decisions they make are correct; as a result, later in the debriefing, they will have those correct decisions reinforced. Some decisions they make are incorrect, thus identifying the knowledge gap by their error. In essence, the simulation has done what it was designed to do by this action. It has ferreted out those knowledge gaps in the psychomotor, cognitive, or affective elements of their learning. The question now becomes, How aware is the learner to that gap?



As the student enters the debriefing, the tools of a skilled facilitated debriefer coupled with audiovisual recordings of the simulation act as the catalyst for learning. In this setting, as previously described, the debriefer reinforces to the students the correct behaviors, often showing them in the video and commenting on their effectiveness. This reinforces previous learning and increases the likelihood of the learner repeating that action in the future. When a knowledge gap is identified, the debriefer must first make sure the learner is aware that the gap is present in their actions. This process is aided by the use of audiovisual technology since often the learner's acts speak for themselves; however, identifying the action does not explain why the student chose that action. This requires reflection on action, as proposed by Schön (1983, 1987). Socratic questioning on the debriefer's part to ferret out the student's exact thinking process is a critical element in this reflection. Once that process has been identified, the debriefer directs the learner towards considering the consequences of that action and consideration of alternate pathways.

In Kolb's experiential learning model (1983; Kolb et al., 2001), following the identification of an incorrect pathway, learning occurred when the student chooses a different action if given a similar situation. Reflection on that action, as described by Schön (1983, 1987), plays a crucial role in their learning from this experience. These same concepts exist within the simulation learning model I have constructed. If, in exiting the reflection process, the student correctly changes their future behavior to the knowledge gap element, then correct learning has taken place. If they don't change their behavior or decide on the wrong alternative action, then incorrect learning has taken place. If they reenter a new simulation or a "live" experience and face the same

knowledge gap element, they repeat the entire process. If correct learning has taken place, then this repeat will result in reinforcing that previous learning. If incorrect learning has taken place, the student will yet again have the opportunity to learn the correct actions.

This model and process that I have identified is how students learn within the high-fidelity simulation environment that includes audiovisual and instructor-facilitated feedback. It encompasses all learning elements, whether they be from cognitive, psychomotor, or affective domains. It encompasses the many different comments and thoughts students have conveyed in the qualitative data sections of this dissertation. In short, it is how simulation learning occurred within this study.

In answering the overarching research question, the simulation environment—when properly constructed—provides a holistic learning environment for students to learn that which they do not know through autonomous practice of their entire gamut of learning applied to a realistic task with measurable outcomes. Students are given the opportunity to learn from their mistakes under safe conditions that allow for the committing of human errors without the associated costs to human life. This learning encompasses elements of leadership, teamwork, situational awareness, communication skills, assessment, medical skills, medical treatments, safe practice, and more.

### **Contributions to EMS Education Research**

This study contributes to the current EMS education research in the following ways:

1. This study was one of the first EMS-based simulation studies that combined all of these elements (leadership, teamwork, medical practice, attainment of EMS

competencies, errors, context of learning, augmentation of clinical experiences) within one study in the initial education of paramedic students.

2. This study confirmed some of the work of previous studies in the effectiveness of using simulation as a learning methodology for the initial education of healthcare students—with particular application to EMS students.

3. This study showed how the context must be modified to make simulation more conducive to learning for EMS students. The use of multiple environmental simulators serves as a more true representation of how EMS calls occur in the pre-hospital setting.

4. This study showed the importance of safely learning through committed errors using simulation. This method is unique and differs from other traditional learning methods, allowing for autonomous practice and safe learning from errors.

5. This study shows how simulation can be used to augment and improve the clinical experiences for EMS students. This includes the attainment of clinical competencies and skills.

6. This study provides a methodology in how to teach and experience leadership skills within a paramedic curriculum.

### **Conclusions**

When I entered this study, I knew something profound was happening with our students in the simulation lab; however, I didn't know exactly what. When I started this study, I never intended it to last 4 years; however, it has. Over the 4 years of this dissertation, with the help of my colleagues, I have run 394 simulations with 81 students producing nearly 500 hours of recorded video (53 hours of briefing, 194 hours of

simulations, 249 hours of debriefings). Chapter 4 describes the journey I took to improve the quality and consistency of graduates from the program. There has been an incredible amount of learning that has taken place in both students and instructors alike.

When we entered this study, we didn't know what we didn't know—much like the students in this study. We learned, as they did, because we kept asking open-ended Socratic questions. The answers to these questions eventually led us to the development of themes that we observed. From those themes and copious amount of data, a model emerged that explains the learning we were observing.

In the end, we learned we did not know what we did not know. We did not know that there were serious gaps in the learning of our paramedic students who graduated the program. We learned that these gaps could be ferreted out through the use of simulation. We did not know that there were better methods to provide more uniform clinical experiences to our students through the use of simulation. We learned this from the students' own comments. We did not know our clinical sites access might be reduced and that simulations could be a solution. We learned this by designing additional simulations and asking both the students and others about their competence. In short, as I write the conclusion to this study, I now know what I didn't when I started it. I will end this study with some of major learning points I learned in performing this research.

### **Conclusion Learning Points**

1. Students don't know what they don't know and need a mechanism to discover it, and then learn from it to change their behavior. Simulation provides that unique mechanism. The simulation learning model I created helps to describe how this learning takes place.

2. Paramedic students need a place where they can gain experience, practice what they have learned, and learn to be leaders in a safe and non-threatening environment. High-fidelity healthcare simulation provides that place without risk to human life or the psyche of the paramedic student.
3. High-fidelity healthcare simulation is a process to apply all domains of learning in one place. This is a unique learning technology significantly different from lecture, laboratory or clinical settings. You get the experiences from the clinical setting with added control and the ability to review performance. You utilize all facets of learning (cognitive, psychomotor, and affective) domains in its use.
4. High-fidelity healthcare simulation is a strong ally to clinical experiences in that it can provide the consistency that they lack while allowing for the building of the individual's experiences.
5. High risk and sentinel events can be experienced in a simulation lab to better prepare students rather than experiencing them in real life for the first time.
6. Simulation provides a unique holistic learning environment where students can learn from their mistakes without the danger of harm to humans.

### **Limitations**

Using preexisting data from an EMT program, this study examined the implementation of high-fidelity healthcare simulation at one Michigan community college. It is believed to be representative of many other similar programs across the United States; however, it is unknown if students at other colleges are more or less reflective than those experienced in the study. Likewise, the primary researcher, the EMS Director in this study, was intrinsically embedded within the experiences of the students

and staff. What psychological or motivational effect this may have had on students is unknown. Motivations and professionalism of individual students are not 100% known. This could have resulted in quickly completing tasks or mute discussions during simulations to decrease time and therefore expedite completion of the module.

Likewise, the clinical experiences available to students within this program are specific to the area in which the college resides. In other regions, it is likely the experiences could be better or worse, depending on the specific availability of clinical sites and their willingness to allow paramedic students to practice within their realm. It is known that clinical opportunities, such as the availability of live endotracheal intubations, vary between programs (Johnston et al., 2006). It is also known that not all programs are able to complete the number of competencies (Salzman et al., 2007). The actual hours students participated in clinical experiences were based on the Paramedic National Curriculum (NHTSA, 1998) and may also not represent what is required at other programs, which could be more or less than the recommendation.

Finally, within the study, depending on the cohort year, a minimum of 30 to 65 hours were spent in simulation over the course of a year. While this represented a minimum of 14 to 32 simulations per cohort, it is unclear whether or not the actual simulations and numbers chosen were ideal. It is possible that fewer simulations could be equally effective or more could be more effective. The most profitable number is unknown, and this may be a factor based more on what clinical opportunities are available in a specific region where a paramedic program is conducted.

## **Recommendations**

I've spent the last decade of my life closely learning and studying high-fidelity healthcare simulation. This study culminates much of the learning that I have acquired in trying to answer the many questions I had regarding high-fidelity healthcare simulation. Upon completion of this study, I have some recommendations to those who are interested.

### **Future Student Practitioners**

Make a wise choice in the program you plan on attending. Do they have a mechanism for ferreting out what you don't know that you don't know? I'm not talking about just a written or practical skills test, but an all-encompassing method that allows you to practice all of your gained knowledge and wisdom so that you will be confident in what you know and learn that which you don't? I believe the presence of a high-fidelity healthcare simulation program that is properly constructed can save you from making perhaps fatal mistakes in the future. It is a safe way to learn a profession without incurring a human cost to those learned lessons.

### **Educators**

If you're not using high-fidelity healthcare simulation as part of your training program, you are missing an invaluable component in your education process. We didn't know what we didn't know about the importance of this methodology until we engaged it in this research. If you read this study, you will have a roadmap to start your journey. Your students will be the ones who benefit, as a result.

## Administrators

There are some important lessons to understand regarding the implementation of high-fidelity healthcare simulation within an academic program. It is an action that is taken to improve the quality of the graduate and efficiency of learning. The use of clinical facilities is a very beneficial part of the practitioner's learning process. Simulation does not replace it; however, simulation augments it by allowing a place for students to practice without harming others. It provides a safe place for the learner to find knowledge gaps by making mistakes, then learning from them in what is a high-risk industry (medicine). There is no other place I know of that duplicates this level of learning in a safe manner.

It requires planning and dedicated resources to be successful. Technology failures and frustrations are part of the process that should be expected—for as this study pointed out, we often don't know what we don't know. High-fidelity medical simulation requires a lot of resources both in the initiation of it and in its long-term maintenance and operation. It is not like other traditional instructional methods regarding student-to-instructor ratios or class size. For instance, I have found that the types of simulations we do require two people to run the simulation. That needs to be planned on in the cost recovery model. All the technology (manikins, cameras, recording equipment) will require regular maintenance and eventual replacement. All of this has to be factored into the operations plan.

## Policy Makers

For those making policies, the underlying question in considering this technology is, What is the value of a human life? This technology directly identifies the knowledge



gaps in learners that lead to treatment errors with human costs. While the implementation of legislation or changes in education standards increases the costs to educate, what is the long-term cost by not providing this mechanism? The National Academy of Sciences publication *To Err Is Human* (Kohn et al., 2000) would suggest it is exorbitantly high. Policies and financial resources should be directed towards developing and implementing this technology in all EMS education programs.

### Researchers

If you've read my study, you realize that getting the context correct is perhaps one of the most vital aspects to successful research in high-fidelity healthcare simulation. I have witnessed a number of individuals profess to doing HFMS only to find that their context is unrealistic or flawed. As I learned in year 1 of this study, getting the context correct is imperative. Spend the time to get it right.

Regarding future research, this is an industry in its infancy. There are many topics that I see that need research. Just from this study I see several:

1. How much audiovisual is the "right" amount to use in debriefing?
2. What is the cost savings of using simulation versus allowing injury or death to patients as a result of human errors?
3. Given this new simulation environment, can the time used to produce a paramedic be reduced while improving the learning experience? By how much?
4. What clinical elements are better handled in a simulation setting?

## Manufacturers

The simulation industry would not be possible had it not been for manufacturers who developed and refined the various products used by those who conduct the simulations. Thank you. While the current crop of equipment allows us to perform simulations in a way that was not possible in the past, more focus needs to be made on reproducing the human communication elements needed in assessing patients. The ability for facial movement and hand grasping would be valuable features to improve the lifelike appearance of the manikins. There have been some serious problems with the quality of customer service I experienced while working with manikins from all three major vendors. It is the customer who will drive this industry forward, resulting in profits for those manufacturers that are responsive to their needs. Customer support is at least as important as the manufacturing process.

## The EMS Industry

I have heard many arguments against why high-fidelity simulation can't be implemented in EMS education. These range from time constraints to the high cost; however, future practitioners need a place to safely make mistakes and learn from them so that the patients aren't harmed. The students who participated in this study understood this and commented loud and clear to me about how important they felt it was in their education. I will end this dissertation with the comments from one of the third-year students who is now a licensed practicing paramedic. While his comments were made in his exit interview, they speak directly to the EMS industry and all those involved in EMS education. He stated,

My comments would just be this is something that we, as an EMS industry, should require this type of learning opportunity because having now spent a certain number of hours with other individuals who have done paramedic programs either in the recent past or currently at other educational institutions, I mean to compare my knowledge, my comfort level, and my ability to function in that setting to theirs, both in terms of my personal observations and in terms of what the—the preceptors tell me about students from other programs, there's no comparison. . . . The students coming out of this program are students that are impressing preceptors, whether it be in a hospital or on the ALS rigs. [By not doing this,] . . . you're making a mistake and you're hurting EMS as an industry, and the patients that we treat.

## APPENDICES

## APPENDIX A: SAMPLE SCENARIO FROM INTRODUCTION MODULE

The following module is an example of the format and design of the scenarios used within the study. This scenario was the first scenario students encountered following their introduction to the simulation lab. Within the that day, students performed a scavenger hunt to acquaint them with the different simulators, manikins, and equipment. Following that, they were briefed about the what their actions should be in the scenario, however the exact nature of the patient's condition and treatment was never revealed. Following this, they entered into their first debrief.

Within the module the objectives were chosen from the current teaching curriculum. The simulation type gives a quick overall description of the scenario. The description is an overall description of the events which are expected to transpire during the simulation. Equipment and personal outline what resources will be necessary to conduct the simulation. The event sets are logical segments of the simulation, much like the acts in a play, which contain the specific information for that event set along with expected actions by the responders. The scoring is based on the specific importance of that task to the specifics of the scenario. Finally, at the end of the scenario is a programming reference for the manikin and specific protocol(s) which may be referenced within the scenario.

## Appendix A: State of Michigan Respiratory Distress Protocol Algorithm

**Simulation Name:** Adult with undiagnosed pneumonia complicated by preexisting COPD

**Objective(s):** (Reference: DOT Paramedic National Standard Curriculum (NHTSA, 1998).

- 5-1.10 Identify the epidemiology, anatomy, physiology, pathophysiology, assessment findings, and management for the following respiratory diseases and conditions: (C-1)  
Emphysema  
Pneumonia
- 5-1.11 Recognize and value the assessment and treatment of patients with respiratory diseases. (A-2)
- 5-1.12 Indicate appreciation for the critical nature of accurate field impressions of patients with respiratory diseases and conditions. (A-2)
- 5-1.13 Demonstrate proper use of airway and ventilation devices. (P-1)
- 5-1.14 Conduct a history and patient assessment for patients with pulmonary diseases and conditions. (P-1)

**Simulation Type:** Practice of COPD/Pneumonia adult treatment with critical thinking skills differentiating chest pain diagnosis from a respiratory versus cardiac source.

**Description:** This simulation involves the dispatch of an ALS crew to a patient initially diagnosed as chest pain with shortness of breath by the dispatcher. Upon arrival, the crew will find a 54 y/o agitated patient with a history of COPD and home oxygen therapy at 2 l/m. Patient will be coughing a dry unproductive cough. Patient has a 25 year history of heavy smoking. When pushed, patient will state he smokes occasionally at a half a pack/day. Today, he tried twice to smoke but couldn't breathe and stopped. In reality, he actually has undiagnosed pneumonia complicated by their pre-existing COPD. However, patient will complain of chest pain and shortness of breath. They will state their chest "hurts", though this is actually caused by increased accessory muscle use especially for the past 24 hours. Patient will deny any relief from the pain with posture; however will not tolerate lying flat. Patient rates chest pain at "4" of 10 scale with no relief. When questioned, they will confirm diaphragmatic pain. Some cyanosis will be present with pulse ox of 87%. Breath sounds will be absent in the lower right lobe with crackles in the lower left and rhonchi in upper lobes. Inspiratory time will be lengthened due to COPD. If asked, patient will indicated slightly more pain in inspiration.

If more thoroughly questioned, patient history indicates that patient has been steadily getting worse over the past 3 days. They have had a non-

productive cough (which is normal for them) and “night sweats” last night. They have used their short acting inhaler twice without much success. That, along with chest pain, is the reason for calling.

ECG will be normal both in 3 lead and 12 lead with no ST elevation. If respiratory distress protocol is followed, patient should be given albuterol treatments (2 enroute) and have standard ALS treatments performed (IV, Monitor, Oxygen). Steroids should be considered and an order requested from Medical Control. Steroid administration will be denied. High flow oxygen should be administered and CPAP/BIPAP considered. Scenario will end with transfer of patient and report to ER staff. Paramedic must complete their run form prior to debriefing.

If cardiac protocols are followed, nitro administration should show a marked fall in pressure with no relief in the pain. Patient agitation will increase markedly. Respiratory arrest may be considered if treatment becomes overly aggressive for chest pain.

If low flow oxygen is continued, patient will continue with low pulse-ox of 88%. As more agitation occurs, sats may drop to 83%. Nasal intubation will be denied by medical control and at no time should the patient respiratory rate drop below 24 b/m. Patient will be tachycardic throughout scenario due to inhaler use and hypoxia. If medium to high flow oxygen is given, sats will rise to 93%. (This is about as good as it gets on his own.) Albuterol (Atrovent) administration will result in decreased anxiety and some relief of hypoxia.

While patient is agitated, they are also curious what is happening and slightly scared. Patient will question medics if they ask whether or not he has had flu shots. Example: “Have you had the influenza vaccine?” “No, ...do you think I have that pig flu? Oh, my. Will that do this?” Example: “Do you have a history of any heart problems, heart attack?” “No, is that what I’m having now?”

#### Option A

If there is a desire to test a crews monitoring of the patient, if high flow oxygen is given, patient respirations will begin to fall gradually to 8-10/min over 5-10 minutes. Sats will drop to 84%. Patient will not lose consciousness, however they will have high anxiety/panic. Respirations may increase at this point resulting in mild increase in oxygen saturation (89%). This may trigger a desire to nasally intubate or sedate the patient and orally intubate. Both requests should be denied by online Medical Control. Rather, order a decrease in the oxygen flow rates which will result in increased respirations.

Option B

When attempting to establish an IV, Paramedic can be denied a patent IV. If done prior to administration of albuterol, this may cause a minor concern regarding order of treatment. Should the albuterol be withheld until a venous line is established?

**Required Equipment:** HAL, Monitor Tablet, ALS Ambulance Simulator, Living Room Simulator, ECG Monitor, Ambulance Cot, ALS Jump Kit, Med Box, O2 Kit, Portable Radios (4), ER Simulator, Home oxygen tank with cannula, BLS Jump kit and oxygen.

**Required Personnel:** Man for voice of HAL, Sim Operator.

*Event Set 1*

**Conditions for Event Set 1.**

**Setting:** Patient found in home on padded chair with oxygen tank via nasal cannula running at 2 l/m. Patient sitting slightly forward.

**Information:**

**Information to be given to responding crew:**

(“Prior to this call, you are working a standard shift on an ALS Ambulance. The other 1-2 of you are working a BLS Fire Response. Make sure your equipment and unit are ready for the next call.) Once participants indicate they are ready, proceed with the start of the simulation. Two students will proceed as the ambulance crew. The other 1-2 students will be first response that arrives nearly simultaneously with the ALS ambulance.

“Respond priority one to 450 North Ave, Apartment 1A for a patient complaining of chest pain and shortness of breath. No previous cardiac history. Fire has been dispatched.” Allow Fire to respond first, and then follow three minutes later with ALS Crew.

**Patient Condition:**

**Reason for Call:** Chest Pain/Shortness of Breath getting worse. “Can’t smoke”

**History:** COPD for past 7 years that is progressing.  
1/3 to 1/2 pack of cigarette smoking/day  
Chest Pain started yesterday and got worse today.  
Kidney Stones (hospitalized twice)  
Chest pain at a “4” on a 10 scale slightly worse on inspiration  
Dry hack cough (non productive)

**Medications:** Lisinopril 20 mg qd po  
Zyloprim 300 mg po



Advair Diskus 250/50 BID  
Ventolin Inhaler 2 sprays q/4-6 hours prn for Shortness of  
Breath  
No known drug allergies

**Condition:** Very anxious and angry that this is happening.  
Unproductive cough throughout conversation.

**Trigger:** Call received.

**Distracter:** Information obtained should not match original information dispatched.

<b>Rate Element from 1 to 5</b> <b>1 = Very Low Probability</b> <b>5 = Very High</b>	<b>Rate Skills and Techniques from 1 to 5</b> <b>1 = Very Low Probability</b> <b>5 = Very High</b>
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<b>Primary Topic</b> <b>PATIENT COMMUNICATION</b>	<i>(1=Very Low 5 = Very High)</i>	
	<b>Element Rating</b>	
<b>Sub Topics SKILLS</b>		
Introduce self/other HC workers, explain role	3	
State directions clearly using commonly understood language	4	
Paramedic/EMT confirms communication from patient (closed end)	4	
Ask for patient and family information and/or input	4	
Request clarification of ambiguous answers	4	
Update patient on changing conditions	3	
Explain treatment plans, rationale and seek consent	3	

<b>Primary Topic</b> <b>INITIAL ASSESSMENT</b>	<i>(1=Very Low 5 = Very High)</i>	
	<b>Element Rating</b>	
<b>Sub Topics SKILLS</b>		
Recognizes Scene Safety	5	
Primary Assessment (rules out life threats)	5	
Acknowledges chief complaint	4	
Patient Communication/Rapport of crew to patient	3	
Crew Communications – Use of closed end communications	4	

<b>Primary Topic</b> <b>SECONDARY ASSESSMENT</b>	<i>(1=Very Low 5 = Very High)</i>	
	<b>Element Rating</b>	
<b>Sub Topics SKILLS</b>		
Recognizes/evaluates Signs & Symptoms	4	
Checks for Allergies to Medications	4	
Checks for medications the patient is taking.	4	
Checks pertinent history to event	4	
Checks for last oral intake	4	
Checks for events leading up to incident.	4	
Assesses Breath Sounds	4	
Obtains full set of Vital Signs.		
Thoroughly questions chest pain/history including previous events to r/o cardiac	3	

<b>Primary Topic</b>		<i>(1=Very Low 5 = Very High)</i>	
<b>MANAGEMENT OF PATIENT</b>		<b>Element Rating</b>	
Sub Topics SKILLS			
Oxygen via NRB titrated to effect early in tx.	5		
ECG Monitor applied and ECG Interpreted	4		
Consider/Apply 12 lead ECG to r/o MI			
Checks SpO2 levels and continues to monitor	3		
IV Attempt Saline	3		
Albuterol Treatment on-scene (2.5 mg nebulized)			
Transports in semi-fowlers or upright position			

<b>Primary Topic</b>		<i>(1=Very Low 5 = Very High)</i>	
<b>SITUATIONAL AWARENESS</b>		<b>Element Rating</b>	
Sub Topics SKILLS			
Recognizes Respiratory Distress r/o cardiac	2		
Announce significant changes in patient status	2		
Transports once patient is stabilized	2		
Evaluate and report on plan outcome	3		

### *Event Set 2*

#### **Conditions for Event Set 2**

**Information:** Patient's response will be determined by actions of the Paramedic crew. If actions on scene result in better oxygenation, then patient will react beneficially. The reverse is also true. ETA to the hospital will be 8-10 minutes.

Consider application of Option A if Oxygen administration is high flow.

Enroute, Paramedic should radio hospital with patient report.

**Trigger:** Patient loaded in Ambulance

**Distracter:** none.

<b>Primary Topic</b>		<i>(1=Very Low 5 = Very High)</i>	
<b>ONGOING MANAGEMENT</b>		<b>Element Rating</b>	
Sub Topics SKILLS			
Paramedic re-assesses patient vital signs.			
Continues communication with patient			
Reassess breath sounds			
Ongoing monitoring of SpO2 and ECG			

<b>Primary Topic</b>	<i>(1=Very Low 5 = Very High)</i>	
<b>COMMUNICATIONS</b>	<b>Element Rating</b>	
Sub Topics SKILLS		
Contacts Medical Control with patient report	5	
Requests Steroid treatment		
Considers Second Albuterol treatment		
Considers CPAP/BiPAP		

*Event Set 3*

**Conditions for Event Set 3**

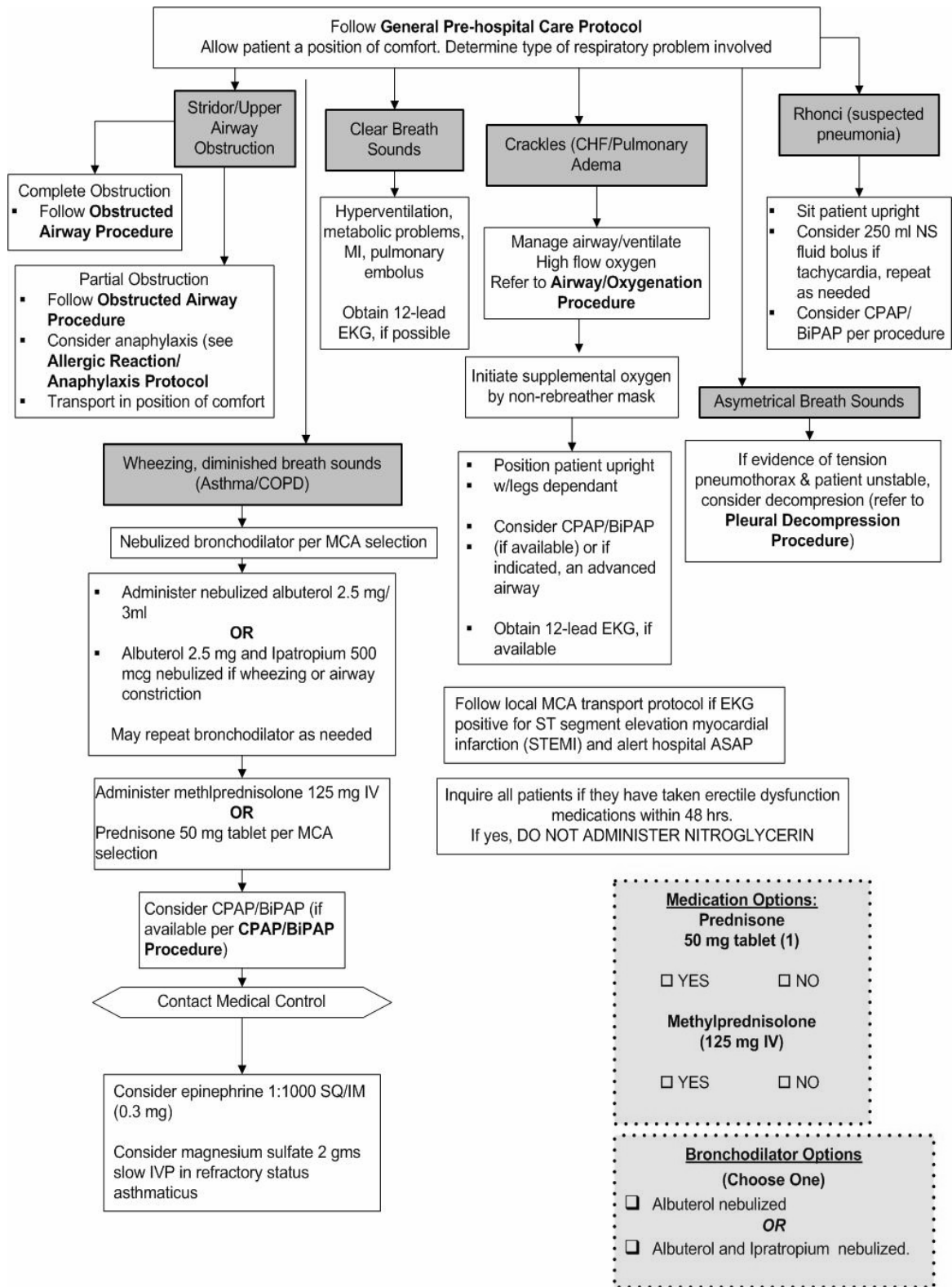
Information: Patient arrives at hospital ER. Paramedic should give a full report to the physician, followed by a patient run report. Scenario ends with submission of patient run report.

**Trigger:** Arrival in Hospital ER

**Distracter:** none.

<b>Primary Topic</b>	<i>(1=Very Low 5 = Very High)</i>	
<b>COMMUNICATIONS</b>	<b>Element Rating</b>	
Sub Topics SKILLS		
Paramedic gives report to Physician		
Paramedic recognizes and informs Physician on suspected diagnosis		
Paramedic completes run report		
Communications are professional and utilize appropriate terminology		

Hal Vital Signs		#1: Initial Assessment	#2: Transport	#3: Arrival ER
LOC		C&Ax3	C&Ax3	C&A x3
Cyanosis Level		40	30	30
Eye State		20/min	20/min	20/min
Pupils	Left	n	n	N
	Right	n	n	N
	Enable Rx-Left	on	on	On
	Enable Rx-Right	on	on	On
	Rx Time	1	1	1
Respiratory	Resp. Rate	23	21	23
	SpO2	87	93	93
	EtCO2	44	42	42
Cardiovas	Heart Rate	112	108	108
	B/P	138/92	134/90	134/90
	Rhythm	NSR	NSR	NSR
Temp		99.2	99.2	99.2
Other		Breath Sounds: Absent right lower, crackles left lower, Rhonchi right and left upper	Breath Sounds: Absent right lower, crackles left lower, Rhonchi right and left upper	Breath Sounds: Absent right lower, crackles left lower, Rhonchi right and left upper



## APPENDIX B: IRB CONSENT AND APPROVALS

This study required IRB approval from both Kellogg Community College and Andrews University. On the following pages are the IRB consent form that was signed by each participant in this study, a copy of the Andrews University IRB approval, and a copy of the Kellogg Community College IRB approval.

# Informed Consent Form

I have been informed that Chester Dalski is conducting a research study, and that my participation in this study titled "Paramedic Professional and Leadership Development using High Fidelity Medical Simulation and Audio/Visual Feedback: One Michigan College Case Study" will enable him collect data for a dissertation done in partial fulfillment of his PhD program at Andrews University.

**Purpose of Study:** The purpose of this research is to describe the student learning taking place using high-fidelity medical simulation within paramedic training program at a community college. This program uses audio-visual recordings and instructor mediated feedback.

**Inclusion Criteria:** In order to participate, I recognize that I must be 18 years of age or older and be a student participant of a Paramedic Curriculum at Kellogg Community College.

**Procedure:** I have been informed that at the beginning of the study I will be given a clinical simulation pre-course survey which I will complete. Surveys, completed run forms, video of briefings, simulations, and debriefings, exit surveys, and any related materials will be made available from the EMS Program to this research program. At the end of my class, I will be asked a series of questions of my simulation experience which will be videotaped for later analysis. This should take less than 30 minutes. I will also be asked to complete a short written survey about the learning which I received during my participation in simulations within the Paramedic Program.

**Conflict of Interest by Researcher:** This research is being done by the Director/Instructor of this program at Kellogg Community College. He does not intend to alter grades according to participation or lack of participation in this study. A PowerPoint presentation will be presented to me in class which discusses this potential conflict of interest.

**Risks and Discomforts:** I have been informed that there are no physical or emotional risks to my involvement in this study. However, in the unlikely event of injury resulting from this research, Andrews University is not able to offer financial compensation not to absorb the costs of medical treatment. However, assistance will be provided to research subjects in obtaining emergency treatment and professional services that are available to the community at generally nearby facilities. My signature below acknowledges my consent to voluntarily participate in this research project.

**Benefits/Results:** I have been informed that there are no direct benefits. I accept that I will receive no remuneration for my participation, but that by participating, I will help the researcher and Kellogg Community College better understand the student learning which takes place using high-fidelity medical simulation.

**Voluntary Participation:** I have been informed that my willingness to use this data in this research is voluntary. Participation in the course is required for a course grade and the grade will not be impacted by my willingness, or lack thereof, to allow the data to be used for this research. Refusal to participate involves no penalty or loss of benefit to which the subjects may be otherwise entitled, and that I may discontinue participation at any time without penalty or loss to which the subjects are otherwise entitled if they had completed their participation in the research.

**Contact Information:** In the event that I have any questions or concerns with regard to my participation in this research project, I understand that I may contact either the researcher, Chet Dalski at [dalskic@kellogg.edu](mailto:dalskic@kellogg.edu) W:(269)660-2324, KCC EMS Program, 450 North Ave., Battle Creek, MI 49017. I can also contact his advisor, Dr. Duane Covrig at [covrig@andrews.edu](mailto:covrig@andrews.edu) (Tel. 269-471-3475), Bell Hall 173, Andrews University, Berrien Springs, MI 49014-0111. He is a professor in the Leadership Program at Andrews University.



September 19, 2012

Chester L. Dalski  
Tel: 269-660-2324  
Email: [dalskic@kellogg.edu](mailto:dalskic@kellogg.edu)

**RE: APPLICATION FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS**  
IRB Protocol #: 12-090      Application Type: Original    Dept.: Leadership  
Review Category: Expedited    Action Taken: Approved    Advisor: Duane Covrig  
Title: Paramedic Professional and Leadership Development Using High Fidelity Medical Simulation  
and Audio/Visual Feedback: One Michigan Community College Case

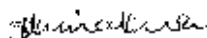
This letter is to advise you that the Institutional Review Board (IRB) has reviewed and approved your IRB application for approval of research involving human subjects entitled: *"Paramedic Professional and Leadership Development Using High Fidelity Medical Simulation and Audio/Visual Feedback: One Michigan Community College Case"* IRB protocol number 12-090 under Expedited category. The approval is valid until September 19, 2013. If your research is not completed by the end of this period you must apply for an extension at least four weeks prior to the expiration date. We ask that you inform IRB Office whenever you complete your research. Please reference the protocol number in future correspondence regarding this study.

Any future changes made to the study design and/or consent form require prior approval from the IRB before such changes can be implemented.

While there appears to be no more than minimum risk with your study, should an incidence occur that results in a research-related adverse reaction and/or physical injury, this must be reported immediately in writing to the IRB. Any project-related physical injury must also be reported immediately to the University physician, Dr. Hamel, by calling (269) 473-2222. Please feel free to contact our office if you have questions.

Best wishes in your research.

Sincerely



Sarah Kimakwa  
Research Integrity & Compliance Officer  
IRB Office  
Tel: 269-471-6361  
Fax: 269-471-6543  
Email: [irb@andrews.edu](mailto:irb@andrews.edu)

Institutional Review Board - 4150 Administration Dr Room 322 - Berrien Springs, MI 49104-0355  
Tel: (269) 471-6361 Fax: (269) 471-6543 E-mail: [irb@andrews.edu](mailto:irb@andrews.edu)



## REFERENCE LIST

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**EDUCATION**

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- 1997 Associates of Applied Science - Nursing, Kellogg Community College, Battle Creek, MI
- 1986 Bachelor of Science – Biology & Emergency Medical Technology, Michigan Secondary Teaching Certificate, Madonna University, Livonia MI
- 1984 Associates of Applied Science – Emergency Medical Technology, Oakland Community College, Auburn Hills, MI

**EXPERIENCE**

- 2007-2008 PSONe/Western Michigan University, Contractor Simulation
- 2007-2009 Siena Heights University-Battle Creek Campus, Adjunct Professor
- 1993-1999 Pennfield Fire Department - Part-time Firefighter
- 1989-1997 LifeCare Ambulance Service - Part-time Paramedic
- 1988-present Kellogg Community College - EMS Education Director
- 1986-1989 Henry Ford Community College – EMS Adjunct Faculty
- 1987-1988 Detroit Public Schools - Middle School Science Teacher
- 1985-1987 Community EMS – Full-time Paramedic
- 1986-1987 Life Support Training Institute - Part-time EMS Instructor
- 1986 North Farmington High School - Science Teacher (student teaching)
- 1984-1986 St. Alphonsus High School - Part-time Substitute Teacher
- 1981-1984 Taylor Ambulance Service - Paramedic & Public Relations Supervisor
- 1981 Medicare Ambulance Service - Basic EMT

**SPECIAL AWARDS**

- 1998 Gold Cup Award, Pennfield Presbyterian Church
- 1995 SWMS Systems, Inc., Certificate of Appreciation Honors
- 1994 Special Recognition Award, American Heart Association
- 1980 Detroit Science Award, Detroit Science & Engineering Fair
- 1980 Second Award, Medicine & Health, International Science Fair
- 1978 Eagle Scout Award, Boy Scouts of America

**LICENSES**

- 1982 – present Michigan Licensed Paramedic
- 1982 – present Michigan Licensed EMS Instructor Coordinator
- 1997 – present Michigan Licensed Registered Nurse